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What's Retarding SUPERSONIC FLIGHT?

EXCERPTS FROM PAPER* BY

Carl E. Reichert, Air Materiel Command, U. S. Air Force

MANY of our problems in design of transonic and supersonic aircraft are fairy ghosts. That's because we have not been able to feel physically the sort of thing our slide rules and small-scale test data tell us.

Remember in high school algebra that if some one had set up the equation for Anne's age, her brother's temperature, and the length of the rope, the solution for how fast the train traveled was simple. That is precisely where we are today. We are trying to set up the equation. We are convinced that we will find a solution and that it will be just a matter of time until that solution is found.

Some of the terms that we are sure will fit into the eventual equation for transonic and supersonic flight are: structures, aerodynamic shapes, control, propulsion installations, materials, armament, and escape provisions.

One of the biggest problems in structural considerations is the increase in loadings with a sizable decrease in space to absorb these loadings. As an example the F-80 in Fig. 1, which travels about 50% faster than the old P-40, must absorb approximately 300% as much load in about the same dimensional space. In another example, Fig. 2, the wing skin thickness in the aircraft of the last World War seldom exceeded 1/16 in., whereas skin thicknesses of ½ in. seem necessary at the present. Wings, which to date have seldom been less than 15 % thick, must not exceed 6% thick if supersonic speeds are to be realized.

The aerodynamic shape of transonic and supersonic aircraft will probably bear only a vague resemblance to contemporary aircraft. Wings and control surfaces will have exceedingly sharp leading edges, as shown in Fig. 3. In fact, it has been suggested that aircraft manufacturers contact makers of razors for their latest on creating sharp edges.

* Paper "Supersonic and Transonic Aircraft Problems," was presented at SAE Southern New England Section, Hartford, March 1, 1950. (This paper is available in full in mimeographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

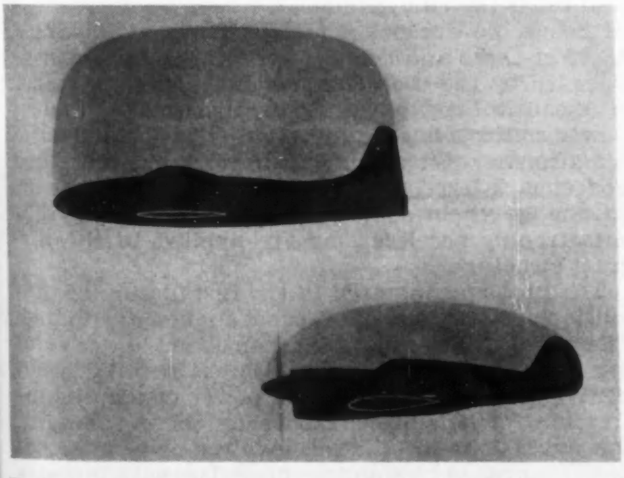


Fig. 1—Higher speeds increase structural loadings. The F-80, upper aircraft, must absorb three times the load of the P-40, lower airplane, although it flies only 50% faster

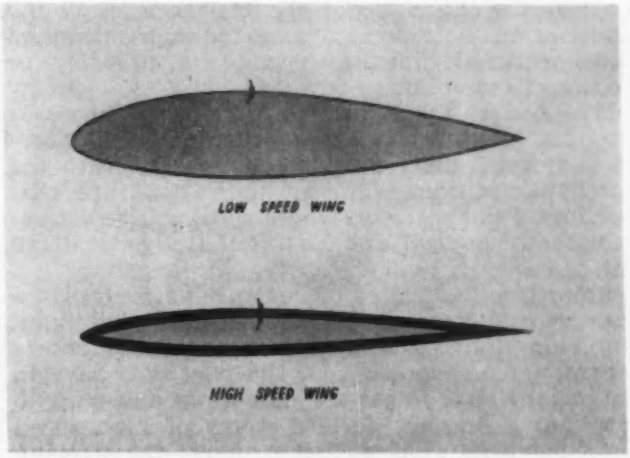


Fig. 2—Supersonic aircraft call for thin wings with thick skins

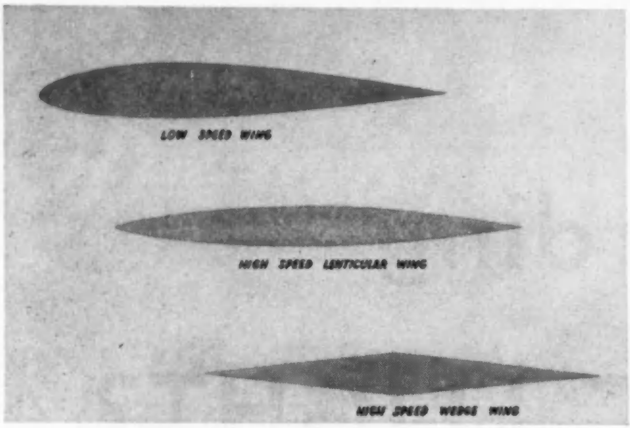


Fig. 3—Sharp leading edges are the shape of wings and control surfaces to come for supersonic and transonic craft

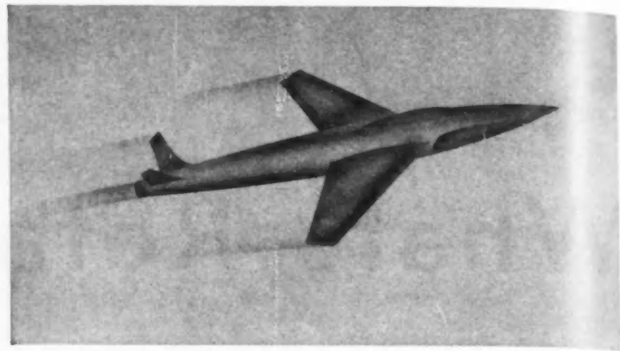


Fig. 4—Wings and tail surfaces also will be swept back

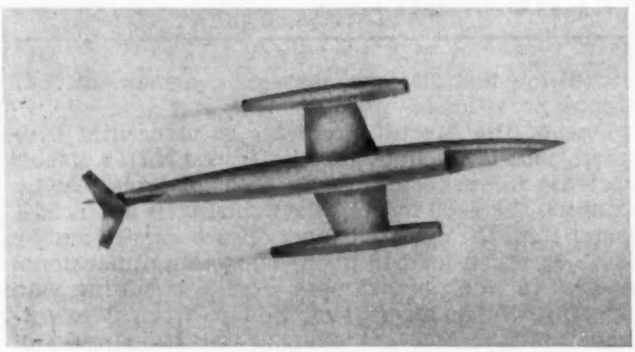


Fig. 5—Supersonic airplane wings will be relatively short in length, only two to three times chord length

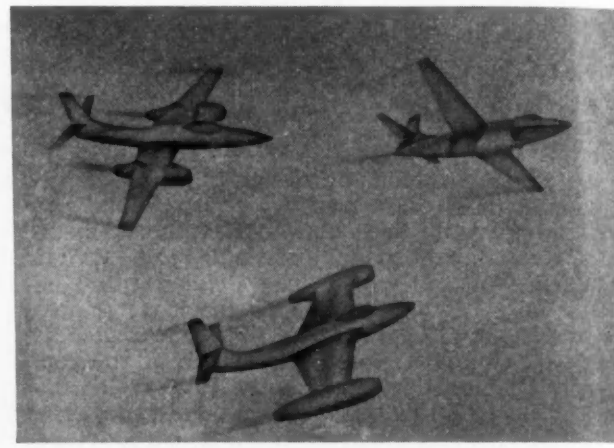


Fig. 6—Powerplants pose tough installation problems, since aircraft are shrinking and power needs are growing

In addition to the sharp leading edges, it appears that transonic airplane will have wings and tail surfaces swept back very much like the paper darts that Junior makes with your favorite sports page. See Fig. 4. The wing of the supersonic airplane—what there is of it—will probably be of very low aspect ratio, that is, the span to chord ratio will be in the order of 2 to 3. See Fig. 5. The fuselages and nacelles will be extremely long for their maximum cross-sectional dimensions and will probably be bodies of revolution.

The bodies will be as free of protuberances as possible. Such things as windshields, radomes, turrets, and antennas will have to coincide with the aerodynamic lines. Present indications are that horizontal tail surfaces, where used, will be set exceptionally high, if not on top of the vertical tail surfaces.

From the standpoint of controls we are not too sure we even recognize the problems, just worries. Our wind tunnels still warn us of some rather severe control force reversals . . . the pilot will have to pull on the stick to get the nose down and push to get it up. Another decided worry of high speed flight has been what we call snaking—the airplane oscillates violently directionally. We began to experience this with our P-51 and were able to cure it. The F-80 then showed the same tendencies and we have been able to cure it.

Ailerons have been another source of control problem, where they vibrate at extremely high frequency and fairly high amplitude. We have named it buzz, although we are not yet too certain of its cause. Most of these and similar control problems can be handled by the use of irreversible control systems. A disadvantage however of irreversible and/or power controls is that the pilot is robbed of feel of his airplane. We are trying to work out a method of feedback force, so that our pilots will not be able to change their course of flight so rapidly that catastrophic accelerations are applied to the aircraft structure.

The problems involved in the installation of propulsion units are one of the most challenging in high speed flight. See Fig. 6. As mentioned under aerodynamic shapes, the airplane size is shrinking violently. At the same time the power demand is increasing. When placed above or below the wing, the powerplant installation involves us in intersections that cause tremendous drag rises with increase in speed.

We have tried design studies with the propulsive

units at the wing tips. They look quite promising on unswept wings, but most data indicate they cannot be tolerated on a swept wing.

Where the number and/or size of units permits, it appears that the fuselage is the ideal spot aerodynamically for the engines; it does not increase the number of intersections and raises the volumetric efficiency of the fuselage. Some of the disadvantages of the propulsive units in the fuselage are: (1) the installation of satisfactory inlets without compromising vision and other functional requirements in the forward portion of the airplane, and (2) the long length of exhaust pipes which, in addition to being a fire hazard, reduces the effective thrust.

Under powerplant installation, fuel also is introducing some problems. Again space limitations cause the greatest difficulties. It seems odd to hear an airplane designer who has always been most weight-conscious say: "I don't care what the fuel weighs, just so it doesn't occupy any space."

Of course as the speeds of airplane increase, the fuel burned per unit of time or distance also increases. As a result of the increase in fuel requirement, the size of our aircraft is mounting in leaps and bounds to maintain range. Fighters that have been weighing 10,000 to 15,000 lb are now approximately 20,000 to 30,000 lb, and bombers of approximately 100,000 lb are nearer 300,000 lb.

Some idea of fuel consumption in missiles can be obtained from considering one which burns nine tons of fuel in a little over 1 min, to deliver a 1-ton bomb approximately 200 miles.

I believe that the problems of materials can be lumped into the conventional strength-weight relation, except that temperature must also be included. Turbo-superchargers, turbines, compressor blades, combustion chambers, and rocket jet materials are of extreme importance. Much work has been done and is being continued on both ceramic coatings and internal cooling to assist in withstanding stress at elevated temperature.

Regardless of how successfully these problems yield to an answer, there will still need to be research on basic materials that will permit still higher temperatures, if we are to realize an increase in thermal efficiency.

Materials of construction also are being given a thorough study from a temperature standpoint. At speeds in the order of two or three times the speed of sound, outer skin temperatures of 300 to 600 F are anticipated. In addition to the structural materials insulation for temperature and sound, transparent materials of high heat and impact resistance and textiles of both high strength and heat resistance are also being studied.

Armament, another very important item in our formula, will also cause some sleepless nights and bald heads before a satisfactory answer in higher speeds in obtained. The air loads on any exposed barrels or launching tubes will be too large to be tolerated. As depicted in Fig. 7, the exposed barrel of a present .50 caliber machine gun will deflect 3 mils when pointed crossways to the flight path at a speed of 400 mph. In contemporary aircraft, even

Continued on page 52

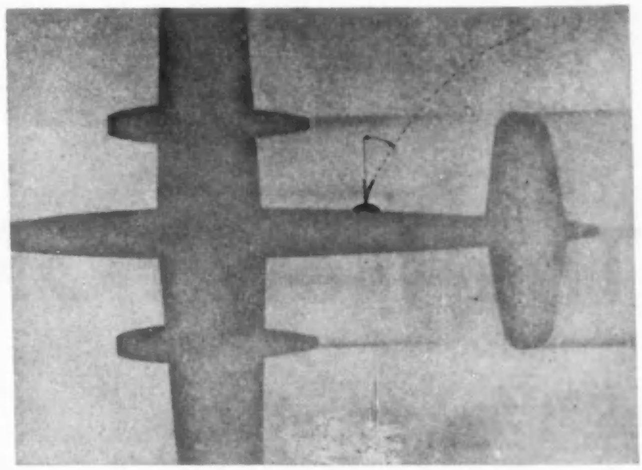


Fig. 7—Gun deflections at high speeds complicate armament problems

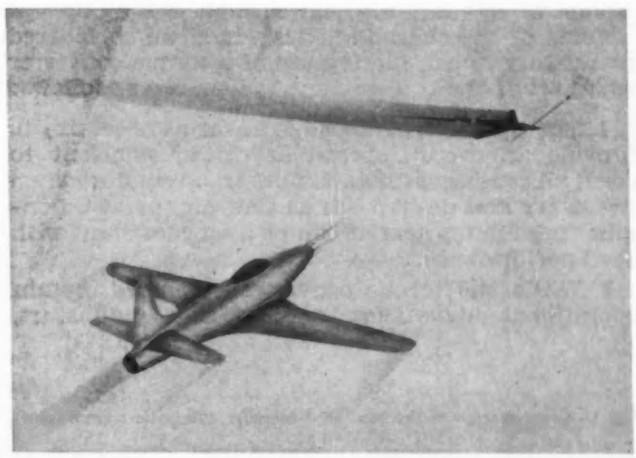


Fig. 8—Only two hits out of 1000 rounds fired are possible, shooting at a 50-ft airplane flying at 500 mph with respect to the gun

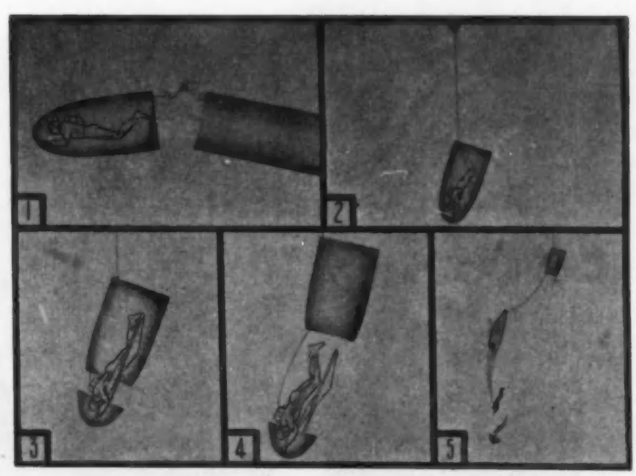


Fig. 9—The speeds and altitudes of supersonic aircraft prohibit conventional emergency evacuation and will require special ejection devices, such as this capsule, perhaps

The New FORD-MERCURY

(This paper will be printed in full in SAE Quarterly Transactions.)

THE new automatic transmission for Ford and Mercury cars, Fig. 1, combines a torque converter and a three-speed gear box. The torque converter is kept in action in top gear without locking up.

Some of the characteristics which we considered mandatory in considering use of a torque converter as a part of the transmission system are as follows:

1. The transmission must go as far as necessary to provide an overall spread of ratios, sufficient to cover all conditions of maximum tractive effort when necessary and desired—to as slow an operating engine speed in top gear as can be used consistent with good performance.

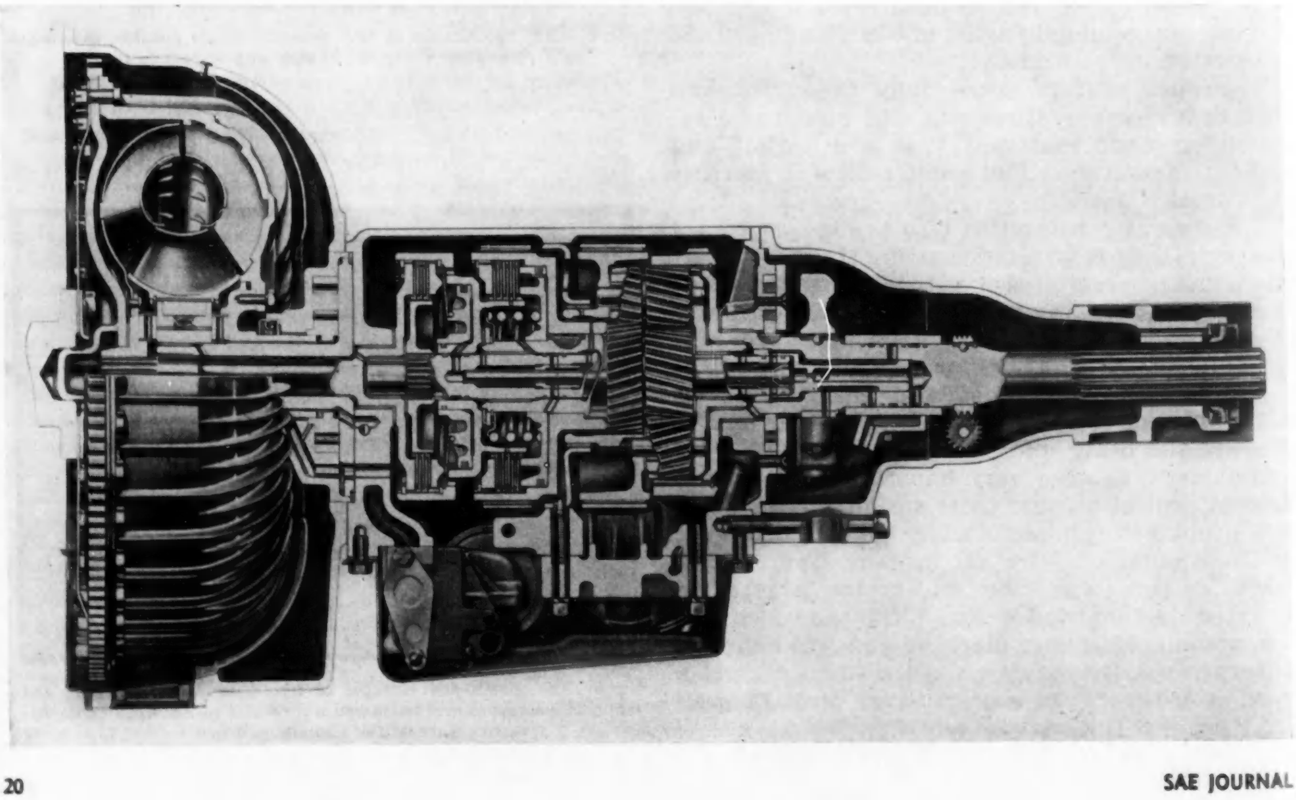
2. While the torque converter combines certain operational advantages inherent in a fluid start, with the ability to multiply tractive effort from stall to a reasonable vehicle speed, it should also be of such a nature as to function with a minimum of slip when operating as a fluid coupling.

3. The inherent torque converter characteristics should be retained in the circuit in top gear to gain the added flexibility of performance that this device gives smoothly and automatically.

4. The automatic power circuit must be capable of giving satisfactory acceleration with the equivalent of second gear start of a four-speed transmission, to eliminate the jack-rabbit start and effect of unnecessary amount of tractive effort for all automatic starts.

Recognizing that the gear box should have sufficient ratios to cover all requirements well enough to allow starting in the equivalent of second gear, three speeds in the gear box were considered neces-

Fig. 1—Cross-section of the new Ford-Mercury automatic transmission



Automatic Transmission

EXCERPTS FROM PAPER* BY

H. T. Youngren and H. G. English, Ford Motor Co.

Vice-President, Engineering | Assistant Research Engineer

sary, two of these being geared and one direct. The intermediate or automatic start of the vehicle consists of one ratio of 1.48 to 1 in the gear box, multiplied by 2.1 to 1, at stall, in the torque converter. This combined with the rear axle ratio of 3.31 gives total starting ratio of $3.31 \times 1.48 \times 2.1$ or 10.29 to 1 —diminishing to 4.9 at 33 mph.

The net overall result is reduced engine speed and a rather pleasant automatic start, with the maximum tractive effort available by a hand shift to the low ratio in the gear box. Necessary also is enough ratio in low gear to get sufficient and acceptable down-hill braking when required. This low ratio is 2.44 to 1.

Another very important consideration is whether it should have a lock-up in top gear. The desirability of keeping the converter in action in top gear without locking up is illustrated in Fig. 2, which indicates the principles involved.

Here we see top gear and next-to-top gear tractive effort curves necessary to give the equivalent of 97 cu ft per ton-mile in top gear. This figure is chosen as it is the average of five leading cars now being sold with Hydramatic, therefore presumably representing engineering requirement as presently interpreted and customer desire of performance in top gear. This is apparently necessary so that shift down is not required for good performance at low car speeds.

Transposed on top of these curves are those with a rear axle ratio that gives an equivalent of 85 cu ft per ton-mile in top gear, but on which has been shown the additive tractive effort below 48 mph, gained by leaving the converter in the circuit. Thus we see that the values shown at "A" are gained without any shift down in gear ratio, the maximum amount being of course with full throttle and in varying amounts depending upon throttle requirements. This condition is effective down to 20 mph,

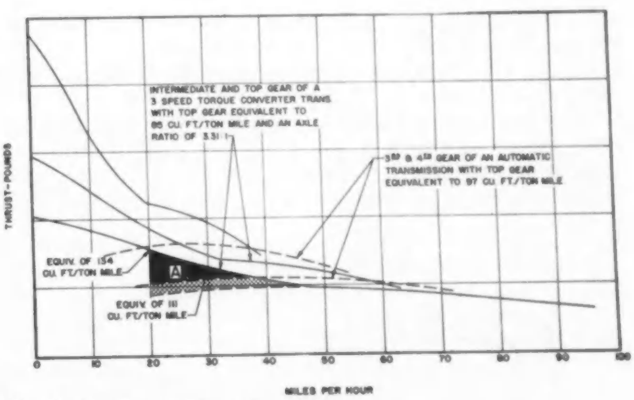


Fig. 2—Comparison of tractive effort

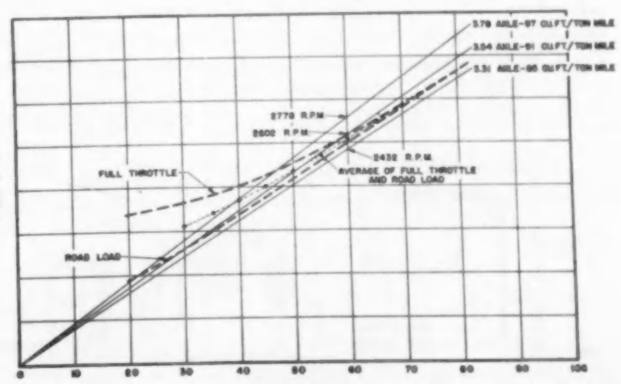


Fig. 3—Engine speed versus axle ratio. Amount of slip is the distance between the curves and the straight lines

* Paper "The Ford-Mercury Automatic Transmission," was presented at SAE Summer Meeting, French Lick, Ind., June 6, 1950. (This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

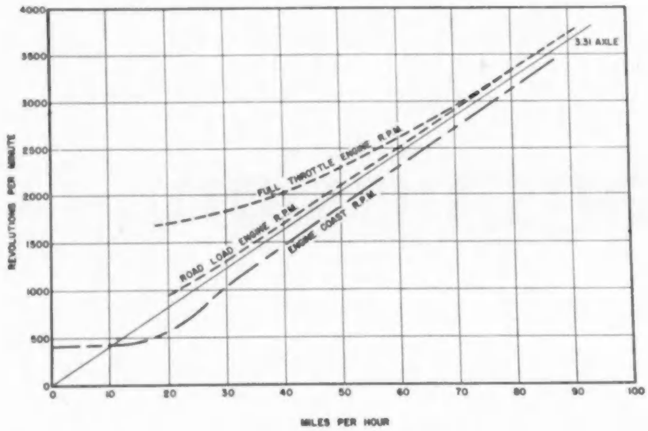


Fig. 4—Converter slip at both full throttle and road load in top gear

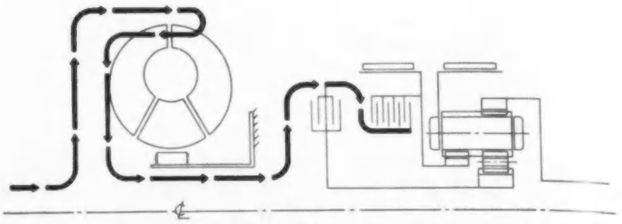


Fig. 5—Power flow of the Ford-Mercury transmission in Neutral

below which the shift down will occur without full throttle and thus bring in intermediate gear plus the torque converter.

Fig. 3 shows the full-throttle and road-load slip curves as applied against the 3.31 axle, the amount of these curves above the straight line indicating the amount of slip. Also shown is the straight line equivalent of 3.54 axle without slip, or as though it were locked up. The 3.31 job is equivalent to an 85 cu ft per ton-mile and the 3.54 axle job is equivalent to 91 cu ft per ton-mile. Above this is shown also another line indicating a 3.78 to 1 axle job which would have been the equivalent if it were necessary to talk about putting in 97 cu ft per ton-mile in top gear.

It is seen from these curves that the average engine rpm's of the 3.31 job with the production converter are somewhat lower than those of the solid drive job with a 3.54 to 1 axle, and a considerable amount lower than if it were considered necessary to have 97 cu ft per ton-mile with 3.78 ratio.

From the gasoline economy standpoint, everything would point to the non-locked up converter job, especially when it is realized that any other losses in such transmissions are the same for both; such mechanical deficiencies as exist, including the driving of the two oil pumps involved, will be the same for both.

In other words, the converter in the circuit puts the zip in top gear at the low end, only where it is needed for this maximum flexibility of driving.

Fig. 4 shows again the full-throttle and the road-load slip curves in top gear. It also shows the coasting curve or the speed that the engine is driven by the vehicle when the throttle is released and would be equivalent to the engine rpm obtained in down-hill braking. This shows conclusively that it is unnecessary to accept a large amount of slip in drive from the engine or the reverse, that is, turning the engine from the rear axle for emergency starts or down-hill braking.

We believe that maximum gasoline mileage in a torque converter-equipped car can be obtained along with superior performance as we have outlined.

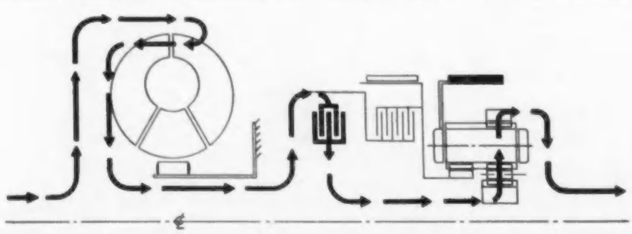


Fig. 6—Both front clutch and rear brake band are engaged with the transmission in Low gear

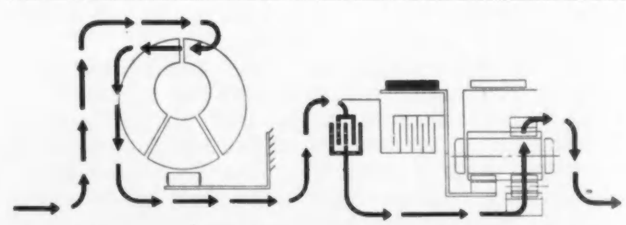


Fig. 7—Power in Intermediate is transmitted through the forward sun gear to the internal gear

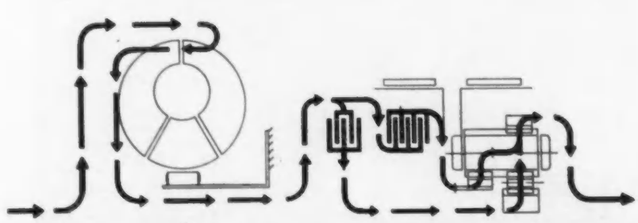


Fig. 8—All parts rotate together in High so that direct drive results through the gear box

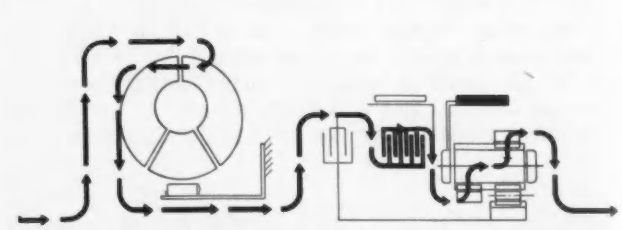
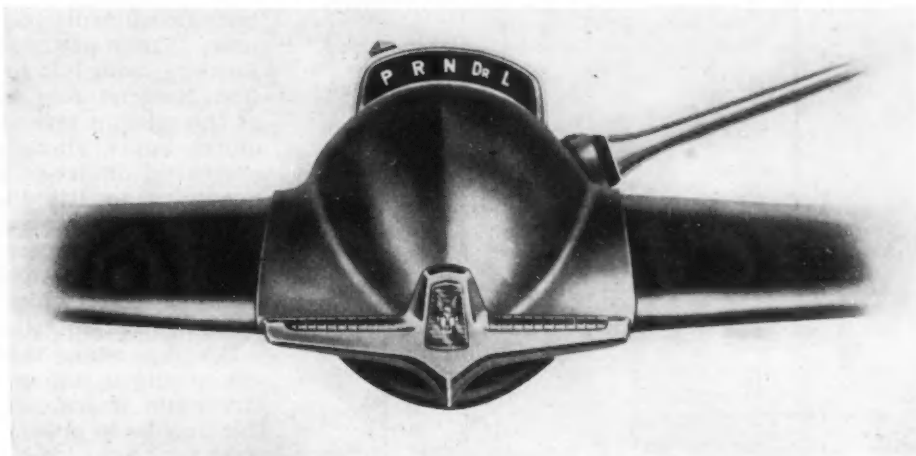


Fig. 9—Engagement of both rear clutch and rear band achieves Reverse

Fig. 10—Selector lever positions for the Ford-Mercury automatic transmission are arranged in a somewhat different order than those for other designs. It minimizes accidental shifting into Reverse



Further development can be expected from the standpoint of simplification and still higher efficiency.

Fig. 1 is a cross-section of the Mercury-Ford automatic transmission. The gear box is of the planetary type to permit shifting under torque, and power from the engine is transmitted through the fluid member at all times. The torque converter is of the simplest type, having but the basic three elements or wheels necessary to provide torque multiplication.

Since the converter is used in conjunction with a gear box of reasonable ratio coverage, its requirement in torque ratio is sufficiently mild as to be favorable to other highly important factors, such as peak efficiency, input speed characteristics, road load slip, and so forth. These factors are of paramount importance since power is transmitted at all times through the converter.

The planetary gear box employs a gear set of the double pinion type with two sun gears and one internal gear. This total of nine gears provides three forward ratios, two geared, one direct, and one reverse ratio.

Two multiple disc clutches and two brake bands, all hydraulically actuated, determine the path through which power flows in the various gears. The forward clutch is engaged in all forward speeds and is disengaged in Neutral and Reverse. The rear clutch is engaged in High and Reverse. The forward band is engaged in Intermediate only while the rear band functions in both Low and Reverse.

Two oil pumps, one driven at all times by the engine and one by the output shaft, deliver oil under pressure to charge the converter, actuate and control bands and clutches, and pressure lubricate the entire mechanism.

The control system consists of a pressure regulator assembly, an hydraulic governor mounted on the output shaft, and the main hydraulic control unit or valve body assembly in which center all of the manual and automatic control functions.

Our automatic transmission employs a gear set so arranged as to provide three forward and one reverse ratio to supplement the torque converter. Gear ratios, converter torque ratio, and overall ratios are shown in **Table 1.**

Torque ratios in High are shown at 20 mph since transmission shifts into Intermediate at full throttle below this speed. Values shown in the last column represent the range of overall torque ratios available in each gear. The larger figure represents the product of overall transmission and axle ratio, whereas the smaller figure is the product of transmission gear ratio and axle ratio with converter at 1 to 1 ratio.

Power Flow

Fig. 5 shows the condition in Neutral with engine idling. Note that both clutches and bands are disengaged. The input shaft to the transmission is driven by the turbine and rotating with it are the front clutch drum and drive plates of both front and rear clutches.

Fig. 6 shows the flow of power through the transmission in Low gear. Here the front clutch is engaged, which couples the input shaft with the forward sun gear. The rear band is engaged, thus holding the planet carrier against rotation. Drive is then through the long and short pinions as idlers to the internal gear on the output shaft.

In Intermediate, Fig. 7, the front clutch is still engaged and the forward sun gear is coupled to the input shaft of the transmission. This time, however, the front band is engaged, which holds the large sun gear against rotation, and the planet carrier is free to rotate in the same direction as the input shaft, but at a lower speed. Drive is still transmitted from the forward sun gear to the internal gear through the long and short pinions.

In High, Fig. 8, both clutches are engaged and both bands released. Therefore, all parts rotate

Table 1—Transmission and Overall Ratios

	Transmission Gear Ratio	Stall Ratio Converter	Transmission Overall Stall	Overall 3.31 Axle
Low	2.44	2.10	5.13	16.98 to 8.08
Intermediate	1.48	2.10	3.11	10.29 to 4.90
High	1.00	1.57 (@ 20 mph)	2.10	5.20 to 3.31 (@ 20 mph)
Reverse	2.00	2.10	4.20	13.90 to 6.62

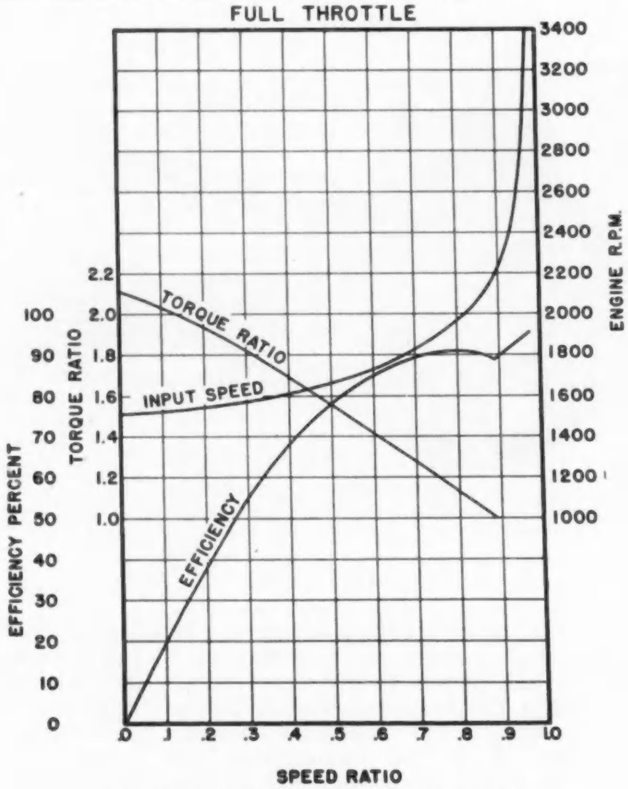


Fig. 11—Characteristics of the torque converter

together and a direct drive through the gear box results.

In Reverse, Fig. 9, the front clutch is released and the rear clutch is engaged, coupling the large sun gear to the input shaft. The planet carrier is held against rotation by the rear band and drive is from the large sun gear across the long pinion only to the internal gear which causes a reversal in direction of rotation between input and output shafts.

Driver control of the transmission is through the selector conventionally located on the steering column. There are five positions, as shown in Fig. 10. Reading from left to right we have the Park position, Reverse, Neutral, Drive and Low. Movement of the selector lever between Neutral and Drive requires but a short motion. To avoid accidental overtravel of the selector into Reverse or Low it is necessary to lift the lever toward the steering wheel as it is moved out of the Neutral or Drive positions. Movement of the selector to the Park position engages a pawl in teeth on the O.D. of the internal gear, which positively locks the driven shaft against rotation.

It will be noted that the positions on the selector are arranged somewhat differently than on other automatic transmissions and some explanation of this may be in order. Since in our arrangement we must pass through Neutral to get into Reverse, the chances of accidental shifting into Reverse are greatly reduced. Because of this, a Reverse inhibitor is not considered necessary and none is provided, nor do we have to go through a forward range to get Reverse. Rocking between Low and Reverse, as is occasionally necessary in mud or snow, is completely adequate with this arrangement.

With the Mercury-Ford transmission, virtually all normal driving conditions are adequately handled in the Drive range. In this range the Intermediate ratio (1.48 to 1) and High (1 to 1) function automatically in accordance with the driver's demands for performance. The Intermediate ratio amplified by the converter torque ratio of 2.1 to 1 at stall provides an overall transmission starting ratio of 3.11 to 1, which amply satisfies all but the most unusual demands for maximum acceleration, gradeability, or downhill braking.

Starting in the drive range is always in Intermediate. The shift to High is automatically made at speeds between 17 and 63 mph, depending on the degree of engine throttle opening. Below 57 mph,

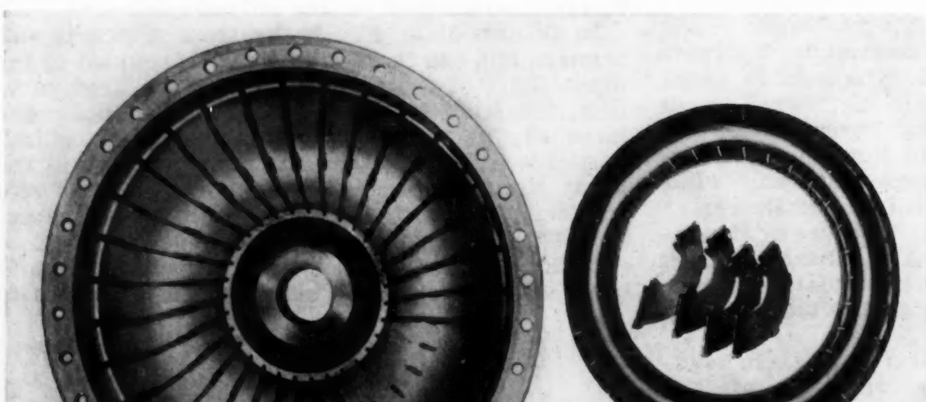


Fig. 12—Stamped steel blades are used in the pump, shown here, as well as in the turbine. Tabs on the stamped blades, which are bent over after being assembled in place, help position and retain the blades in the assembly

Intermediate ratio is brought into use by pressing the throttle beyond the wide-open position. At speeds below approximately 20 mph, downshift to Intermediate occurs at less than full throttle and, under closed throttle conditions, the automatic downshift occurs at 5 to 8 mph.

To fulfill demands for maximum acceleration, gradeability, or hill braking, Low range becomes effective manually by movement of the selector lever to the Low position. At speeds below 40 mph and regardless of throttle opening the shift to Low range places the transmission in the lowest ratio (2.44 to 1). At speeds above 40 mph, movement of the selector to Low downshifts the transmission to Intermediate, in which gear it remains regardless of throttle opening.

This latter feature is advantageous in certain sections of the country where ratio demands fall between Low and High ratios either for ascending or descending grades. Once in Low ratio, it remains there regardless of car speed until a manual shift to Drive position is made. Shifting between Low and Drive is accomplished under torque at any throttle opening.

Description of Torque Converter

In developing the torque converter to be used in conjunction with the three-speed gear box, the following characteristics and features were considered of primary importance: Fig. 11 shows these performance characteristics graphically.

1. Torque ratio slightly higher than 2 to 1 at stall.
2. An engine speed which rises with vehicle speed. This characteristic permits a reasonable stall speed while giving torque conversion to a speed which is sufficiently high (approximately 48 mph) to provide an effective converter range for adequate performance.
3. A high converter efficiency above 0.5 speed ratio. This is a requirement since considerable driving is done in the higher speed ratios of the converter range, particularly in city driving.
4. A high coupling point and low slip when operating as a coupling. These are necessary since the drive is hydraulic through the converter-coupling at all times.
5. A design which would provide integral air cooling.

Fig. 13—The converter and transmission oil are aircooled. Fins cast on the pump cover provide cooling surface and pump cooling air

Our torque converter consists of three basic elements: the pump, the turbine, and one stator or reaction member. The pump is driven from the engine through a flexible plate for a minimum of vibration transfer from the engine to the transmission.

The pump assembly, Fig. 12, consists of an aluminum cover, 31 stamped steel blades, a retaining ring, a torus ring, and iron hub casting. The aluminum cover is die-cast with slots provided in the inside surface to receive the blade tabs. Each blade is positioned in the cover by four tabs and the retaining ring. An additional two tabs project through the torus ring and are rolled over to complete the assembly. The hub, which is bolted on and sealed with a synthetic ring of square section, provides support for the rear of the converter and in addi-

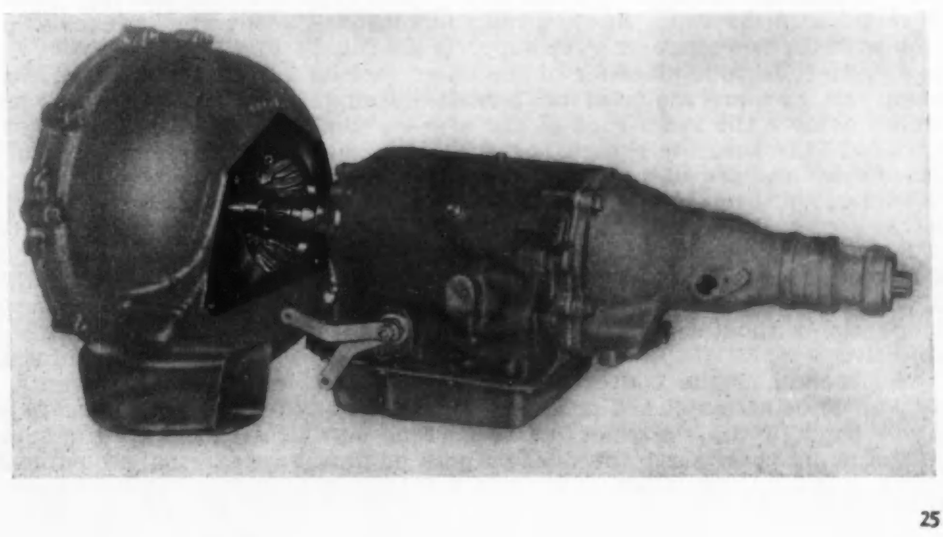


Fig. 14—The gear box can be disassembled from the converted assembly by removing four screws

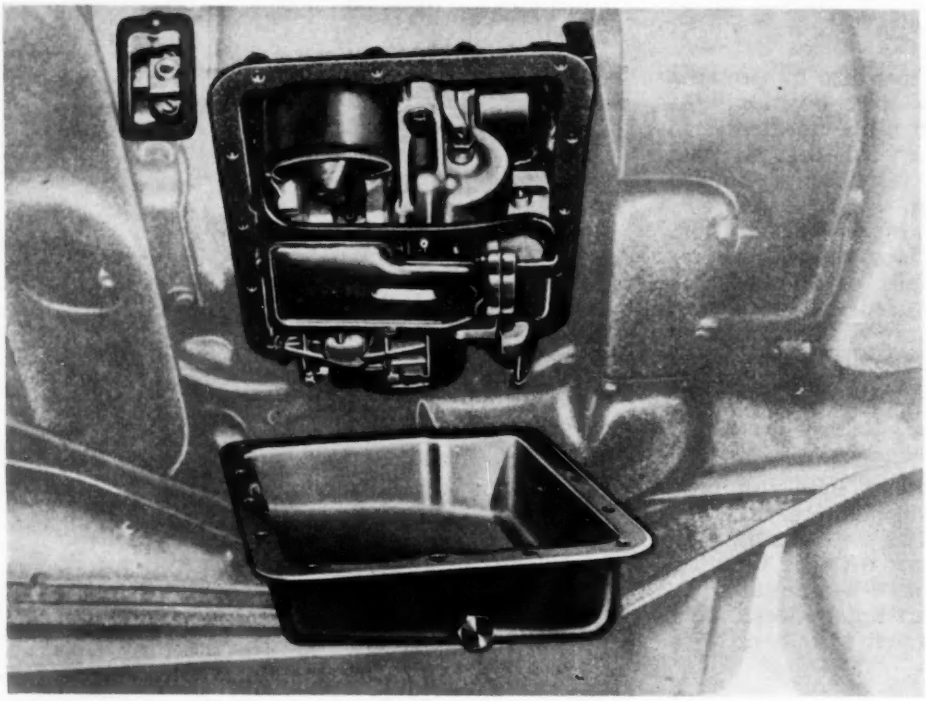


Fig. 15—Removing the transmission oil pan exposes all control elements for easy removal

tion carries two drive lugs for the front oil pump of the gear box.

The turbine assembly is made of steel stampings, except for the splined hub which is a steel forging. The 33 blades are located in the outer shell by four tabs extending from the blade through the shell and held in place by the bending of the tabs. The torus ring is slipped into place over two additional tabs on each blade and these tabs are bent over by rolling. The steel hub is riveted to the outer shell to complete the assembly.

The stator or reaction member is an aluminum die-casting on which a formed split steel shroud is assembled and retained by welding at the split.

The remaining parts in the converter consist of washers which take the thrust between the pump, stator, and turbine, and the assembly of pieces which makes up the hub of the stator. The outer race of the over-running clutch is splined on the outside diameter to receive the aluminum stator and is retained in the stator by snap rings in conjunction with the two supports. The supports are fitted closely to the inside diameter of the outer race at each end and are mounted on babbitt bushings which fit over the inner race of the over-running clutch. This accurately positions the inner and outer races and provides for the proper working of the sprag type over-running clutch, which is nested in the center of this hub assembly.

The above manufacturing techniques in conjunction with the simplicity of the fundamental design of the converter have resulted in an economical fabrication without compromise to the performance objectives.

The cooling of the converter and transmission oil, Fig. 13, is accomplished primarily by air circulation through the converter housing. Fins cast on the pump cover serve the dual purpose of providing cooling surface and vanes for pumping cooling air. The air is drawn in through the inlet at the bottom left side, passes through the converter housing by centrifugal action, and is exhausted at the bottom right side. The heat transfer is of course directly through the aluminum pump cover into the air stream.

This means of cooling is simple, with no plumbing necessary as on a water-cooled job and imposes no extra load on the engine cooling system.

Throughout the design phase of our transmission program, constant thought was given to the matter of weight as well as cost in view of its application to the Ford car. Extensive use has been made of aluminum die castings throughout the transmission. Of the total of 24 die castings, 4 are in the converter and the remainder in the gear box. Total weight of the complete automatic transmission installation is approximately 77 lb over that of the standard transmission.

Service Operations

One of the important considerations in the design of the Mercury-Ford automatic transmission was that of service accessability. We have so designed the transmission that the gear box can be readily removed from the converter housing by removing the four case-to-housing screws, thereby leaving the converter assembly untouched and intact. See Fig. 14.

All control elements such as pressure regulator assembly, valve body assembly, front and rear servos can be readily removed from below after removal of the oil pan. See Fig. 15. The governor assembly can be removed in a matter of a few minutes by removal of an inspection cover on the extension.

Assembly and disassembly of the gear box and the converter are relatively straightforward and simple. Since few adjustments are involved, proper servicing of the transmission by a competent mechanic can be learned rather quickly.

In the entire transmission installation there are only four adjustments. Two of these, the front and rear brake bands, are in the gear box proper, while the others are the manual and throttle rods which are external adjustments, readily accomplished.

THE IDEAL ENGINEER

EXCERPTS FROM PAPER* BY **C. G. A. Rosen,** Caterpillar Tractor Co.

THE composite of the ideal engineer is a stature of many facets.

What are the fundamentals?

The first, I think, is—"Constant discipline of the Mind."

And the second—"Enthusiastic Will to Serve."

How much time do we devote each week to mental discipline? Not just thumbing through magazines, looking at the pictures, and casually reviewing the headlines, but actually doing the thing that is necessary to discipline and analyze and understand the subjects we are reading.

Do we review our old textbooks and bone up on fundamental principles of physics, chemistry and mathematics? Donald McLaughlin does and he is president of a large British mining syndicate covering operations all over North and South America. . . . Do we search out new subjects to broaden the horizon of our technical knowledge? Haraden Pratt does. He's Vice President of International Telephone and Telegraph. . . . How much concerted, concentrated observation do we give to the analysis of passing natural phenomenon? Boss Kettering does. . . . Do we will ourselves to learn the secrets of thought cradled in the minds of men of foreign countries by learning their language and understanding their ways? Den Hartog does and he does it continuously, even to the point of learning some of the native Malayan languages. . . . Could we stand the test of keeping up with a college student?

The Will to Serve

The "will to be of service" makes a catchy slogan. I wonder how much we cultivate the "will to do" and the "will to be of service" . . . to be of service to our job, to our profession, to be of service to our nation, to be of service to the world. Some four years ago Bob Russell, head of Research at the Esso Laboratories of the Standard Oil Co. of New Jersey, was asked to deliver a lecture on "Catalytic Cracking Methods" in Buenos Aires, Brazil. He considered it a challenge to render service as an American engineer to the doubting Thomases in South America. He presented a complete technical lecture with a full discussion period in the native Brazilian Portuguese. He hadn't known Portuguese before, but achieved because of his long years of self discipline and his enthusiastic will to be of service. At short notice he commanded this ability to the mastery of technical Portuguese. Of greater significance, he learned the thinking processes of the South American so he could step into their minds and will their confidence in the integrity of his purpose.

Last year I attended the ninetieth birthday celebration of Professor William Durant of Stanford University. He is responsible for many achievements, but perhaps his most famous work is on Screw Propellers, both marine and air. With extreme clarity of expression and with depth of feeling he thanked his colleagues for the honors bestowed upon him, but his closing remarks are perhaps the more poignant—"The crowning happiness of my life, blessed as it has been by these ninety years, is the joy of having been of service to my chosen profession." You must be a good soldier before you can be a general.

Fortunate is the man who has oriented his directional tendencies. His life has a purpose; he is drawn as by an irresistible lodestone toward the pole star of his career. He need not become a millionaire, a vice president, or a political satellite. All measures of success are relative. Some achieve fame, others fortune, according to certain standards. But under the microscope of one's own peace of mind the measure of one's personal success is:

"What have I wrought in myself that will give satisfaction, will render service, and provide joy in living and in work?" That measure of success any man may attain, and without it no accomplishment is worth the having.

* Paper was presented at SAE Central Illinois Section panel on "Growing in Engineering", March 20, 1950.

Stamped Jet Engine Parts

FABRICATING precision sheet-metal stampings from Inconel and stainless steels for aircraft turbojets calls for elaborate tooling and production ingenuity in forming, location of parts with reference to machined surfaces, and welding. Parts produced for the Allison J-33, General Electric J-47, and Westinghouse J-34 turbojet engines illustrate techniques and tooling required.

A particularly tough forming problem was posed by the burner support plate of the J-47 engine, shown in Fig. 1. The plate is over 35 in. in diameter, and made from AISI 347 stainless. It has an outside flange drawn to a 2/32-in. depth, and eight 8 1/8-in. diameter eyelets drawn to a 1 5/32-in. depth in the opposite direction. Mathematically this is possible only under ideal conditions, since it calls for a 40% elongation of the material.

Here are the five operations that make it possible to fabricate the part: First, the outside diameter is blanked and center hole pierced. This takes 600 tons, although the die has a shear ground equal to material thickness. Second, the outer flange is drawn. Third, the eight eyelet holes are pierced, then carefully polished to remove hidden hairline fractures in the holes. Fourth, all eight eyelets are drawn at once. At this stage the part is annealed and descaled. Fifth operation is a restrike to insure a flat plate to proper dimensions for assembly.

Accurate forming that saves assembly time and operations accrues from pre-piercing and allowing weld shrinkage in J-47 truncated cone parts. Pre-piercing keeps the holes in the same relative position in all finished pieces. It also offers a simple way of relating parts to one another in assembly. Drills, ends mills, or hole saws and related machines to cut holes accurately after assembly are no longer needed. It also minimizes chip removal from confined areas.

Accurate weld shrinkage allowances can be made since all longitudinal seams are welded with automatic gas-shielded arc welding equipment. This greatly reduces shrinkage and variances normal to hand welding.

Among the toughest turbojet parts forming op-

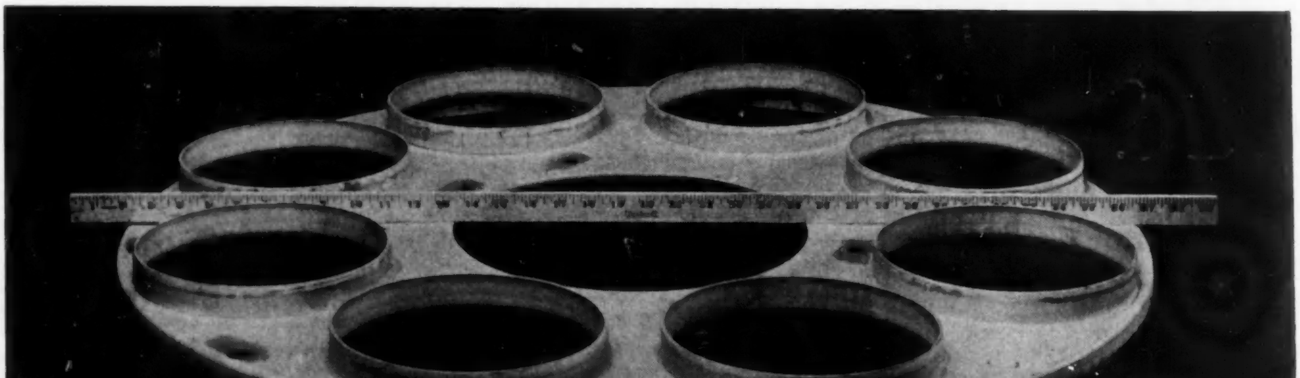


Fig. 1—This burner support plate for the General Electric J-47 turbojet engine, made of stainless steel, is a challenging stamping problem. It calls for a 40% elongation of the material

Made by Special Techniques

BASED ON PAPER* BY **W. C. Heath,** Chief Engineer, Solar Aircraft Co.

erations are lancing and louvering inner combustion chamber bodies and caps. Big job is controlling amount of fracture and burrs.

Lancing, shearing, or piercing is actually controlled fracturing or tearing of the metal. The punch cuts through only about one-third of the material thickness; the balance is fractured or torn. Correct clearance between punch and die leaves the cut comparatively free from burrs. Too much or too little clearance produces too many burrs which must be removed by hand. Burrs from lancing and louvering Inconel (which is much more notch-sensitive than stainless steel), often induce uncontrolled tears in areas of severe draw.

The inner combustion chamber body in Fig. 2 can be reduced to scrap in 294 ways . . . it has that many louvers. Here again two dies are used, each containing 10 punches and dies. The part is indexed both longitudinally and circumferentially to establish the pattern.

Holding to stable primary tooling points greatly simplifies assembly of sheet metal parts, but often costs more to tool. One of these points should be retained as the master point through all operations. If this isn't feasible, using the fewest possible transfers of control will hold down error accumulation.

Massive jigs are used to control assembled parts during welding. One such jig is used in attaching the aft frame support plate flange to support plate. See Fig. 3. Both flange and plate are clamped to hold them in a true plane in the jig. An expander, actuated by a 12-in. hydraulic cylinder at 800 psi, holds the plate and flange to the correct diameter during welding and cooling. The jig is water cooled to speed up the cycle.

The jig keeps the parts flat within 1/32 in. Without the expander, the assembly would shrink and be about 1/2 in. out-of-flat.

After being stress relieved, the welded assembly

* Paper "Precise Methods of Fabricating Sheet Metal Parts," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 7, 1949, as part of panel on "Optimum Engine Producibility." (Complete panel is available in multilithographed form from SAE Special Publications Department. Price: 75¢ to members, $1.50 to nonmembers.)

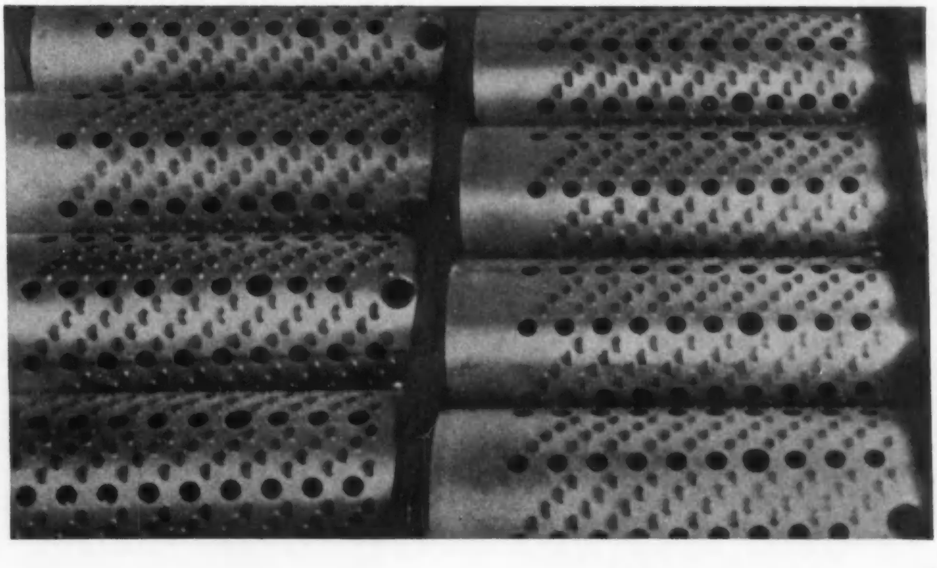


Fig. 2—Louvering turbojet parts, such as this combustion chamber liner, is tricky because the metal is partly cut through and then fractured. Incorrect punch and die clearance leaves too many burrs, which can cause an uncontrolled fracture and scrap the part. Two dies, indexed circumferentially and longitudinally, produce the 294 louvers in this part and reduce scrapping possibilities

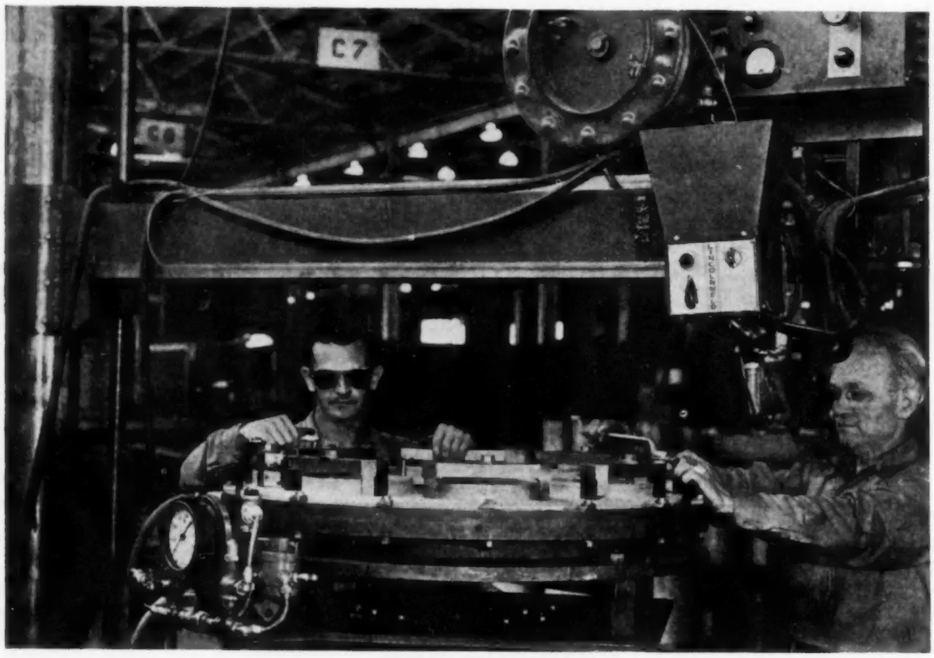


Fig. 3—This heavy jigging for the aft frame support flange for the General Electric J-47 turbojet is typical of the tooling needed to prevent shrinkage and warpage of such parts during welding

is ready for machining. Novel methods achieve accuracy in assembling and machining these parts, yet keep costs reasonable.

For example, the curved inner surface of the J-24C outer diffuser is machined with a contour cam and follow finger on a tool holder, mounted on a vertical turret lathe.

Assembly of diffusers calls for extremely close control to maintain relationship between fuel nozzle rings, inner and outer cones, and welded bosses. Distortion from welding brings problems since diffusor surfaces are finish-machined before assembly. It's even been necessary to locate and spotweld the inner cone out of rotation in the initial stage

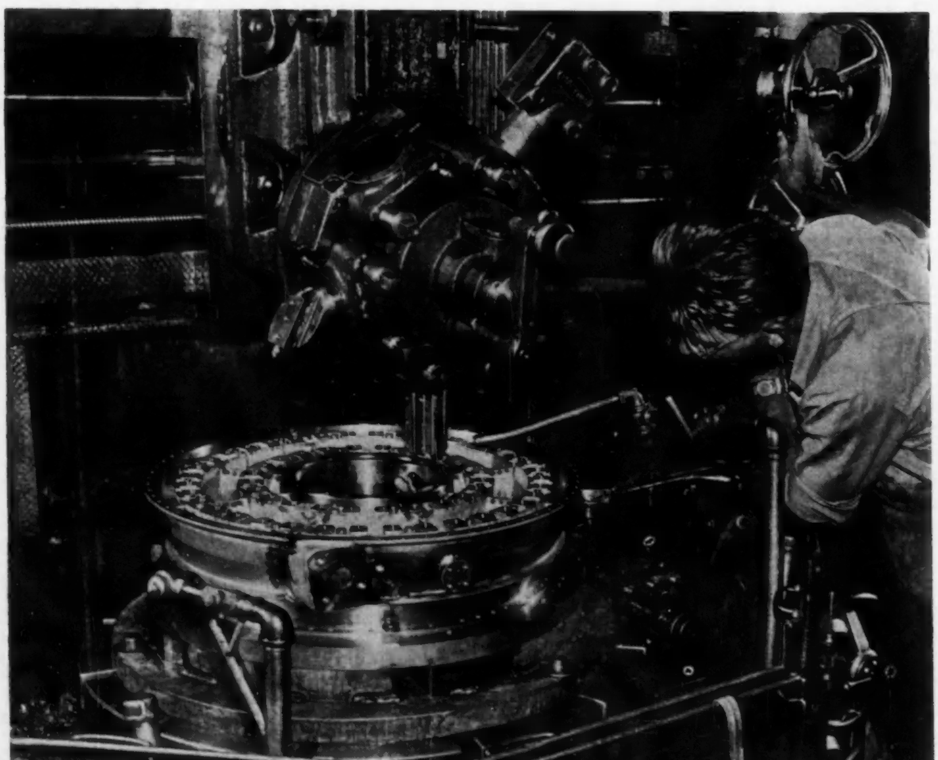
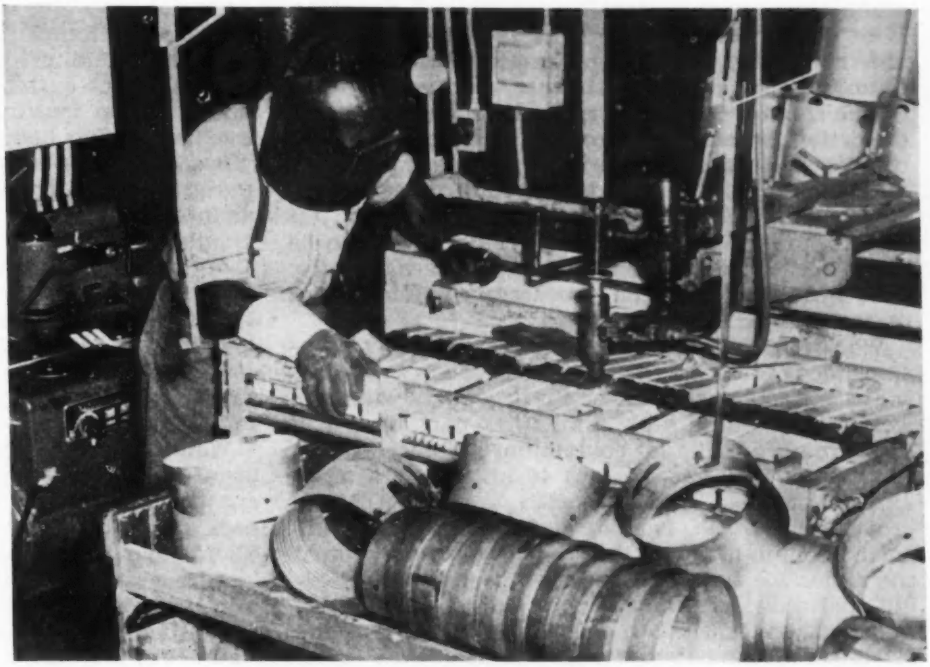


Fig. 4—This diffusor assembly for a Westinghouse jet powerplant requires close manufacturing control because of the many stamping, welding, and machining operations on it

Fig. 5—This automatic shielded arc welder performs one of the fusion welding processes used in turbojet stampings fabrication



to compensate for shift from subsequent welding.

Fig. 4 gives some indication of this particular assembly's complexity. It consists of an inner and outer diffuser cone, two fuel manifolds, struts, fairings, bosses, and tubings—all welded together. There are 318 holes located to a 0.005 tolerance, 168 of which are tapped with NF3 threads; 383 fusion welds; and over 900 spot welds. There are nearly 100 rough and finish machine cuts to tolerances as close as + 0.003 and - 0.000 on 25 3/4-in. diameters. All this in contained in a part 27 in. in diameter by 8 25/32 in. high.

High-temperature aircraft parts are fusion or resistance welding. Fusion welding techniques in-

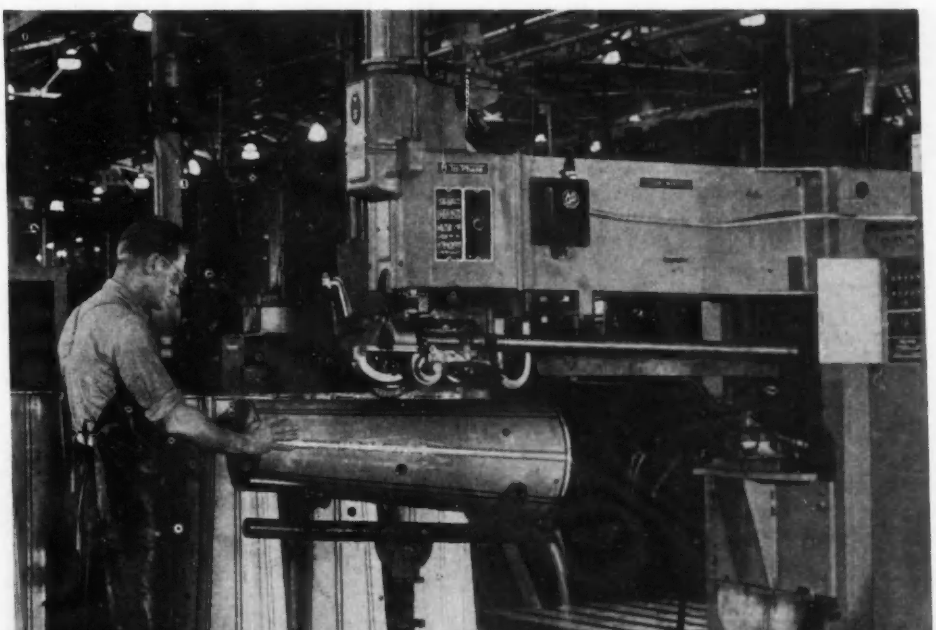


Fig. 6—This d-c roll welder does lots of jobs that conventional a-c equipment can't do. It also eliminates defects common in welding high-temperature alloy parts for jet engines

clude oxyacetylene, metallic arc, atomic hydrogen, inert gas-shielded arc, and submerged arc. Among the resistance welding processes used are spot, seam, projection, and flash-butt welding.

The trend is toward resistance welding. It limits distortion because of localized heating. Because of this, positioning fixtures for resistance welding machines may be much lighter than those for fusion welding. Fusion welding calls for heavy jigs and fixtures if tight dimensional limits are to be met. Because resistance welding produces such low weld shrinkage, it's often unnecessary to allow extra material for shrinkage.

We use both fusion and resistance welding processes, depending on the particular job.

For example, automatic inert gas-shielded arc welding is used on a 0.050-in. thick part, shown in Fig. 5, made of AISI 347 columbium-stabilized stainless steel. Welding speed is 40 in. per min. at 50 amp. A copper chill bar with a 0.187×0.015-in. groove is used. Gas backing is not needed since sufficient helium is forced through the seam to protect the underside from oxidation. This is a butt-welding operation, with no filler rod added. The welding thickness is 0.0025 to 0.003 in. greater than the thickness of the parent metal. Hold-down clamps, positioned close to the weld seam, narrows the heat-affected zone so that warpage is minimized. This equipment also fusion butt-welds Inconel X sheet as thin as 0.010, used in high-temperature bellows.

Inert gas welding processes using helium and argon are coming into more general use. Tests with high-temperature materials in aircraft-used gages show helium is better for machine welding, argon is better for manual welding. High heat transfer across the helium arc makes it tough for the operator to control the weld puddle. Helium shielded gas speeds fabrication in machine applications where fit of parts is ideal. The weld melt is clean, with no oxide overlays.

Its lower heat transfer rate makes argon gas desirable for manual welding. Considerable change in arc length brings no significant change in heat input rate. With argon gas, novices can produce high quality welds after short instruction.

Many developments have been made in resistance welding machines. One is the special adaptation of the direct-current dry disc rectifier type machine. Main feature of this equipment is the low inertia welding head. See Fig. 6. This head provides fast follow-up pressure required by high-temperature alloys to minimize welding defects, such as internal cracking, gas porosity, shrink voids, and expulsion of metal.

Materials and material combinations previously thought unweldable, may be readily processed by this type equipment. For example, this triphase-low inertia machine easily welds monel to mild steel. Welding this combination over conventional alternating current equipment produced severe radial cracking.

Welding with steady direct current instead of the usual 60-cycle alternating current probably shortens the weld time. The alternating current must pass through the zero current point 60 times per sec. Short weld time with direct current reduces heat loss by conduction. Result is less heat dissipation into the work and thus less distortion.

Another unusual piece of resistance-welding equipment is a special company-built, multiple gun spotwelding machine used in assembling the dome, body, and skirt of the inner combustion chambers. Dogs and locator pins position the parts in relation to each other. The machine makes four simultaneous welds per stroke. The part automatically indexes after each stroke of the guns until 24 welds are made. Overall cycle time is 42 sec.

Still another example of ingenious fabrication is the spotwelding of a plate-type heat exchanger, shown in Fig. 7. Clearance for spotweld electrodes is less than ½ in. The stand holding the part is an automatic indexing fixture, energized by exhaust air from the welding machine. The operator merely depresses the firing switch and the machine lap spotwelds at 12 spots per in. At the end of the seam, a microswitch de-energizes the firing circuit. The operator then raises the hydraulic jack and the next weld row is ready.

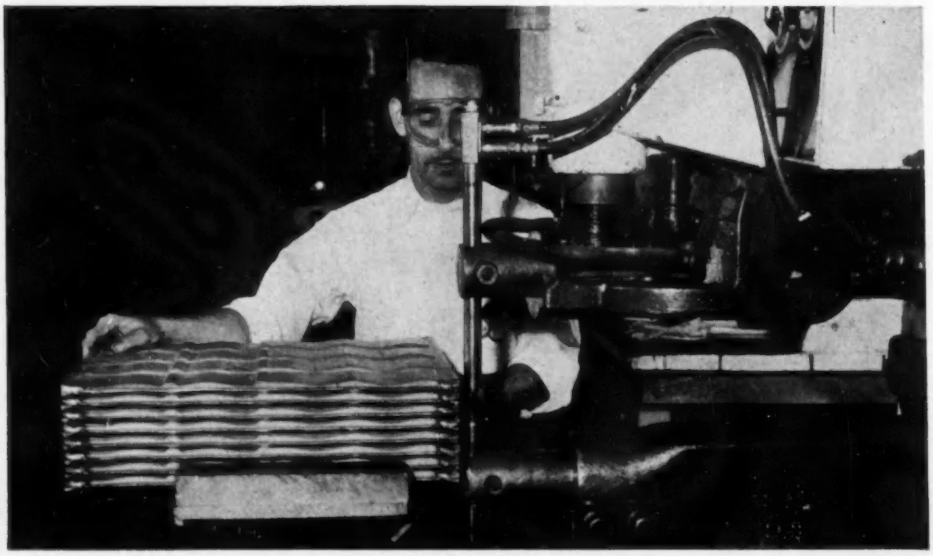


Fig. 7—Electrodes of this spotwelder have less than ½-in. clearance in this heat exchanger core. The machine makes 12 spotwelds per in, with the help of the automatic indexing fixture on which the assembly is mounted

A 1950 Summer Meeting Round Table

Aircraft Exhaust Valves & Seats

Reported by A. L. Pomeroy, Thompson Products, Inc.

Since World War I, much progress has been made in developing better valves and better insert seats for aircraft engines. This has been necessary to keep pace with the fast-moving aviation industry. Specific outputs of aircraft engines have risen steadily, making for more efficient powerplants but imposing serious exhaust valve problems.

Most of the early aircraft valves were made from tungsten. With higher powers, warpage took place and this material was then replaced by Silcrome. Further increases in ratings necessitated a change to C.N.S.

Valve loads continued to increase, which brought about the development of cooled valves. First attempts to produce cooled valves consisted of filling the valve with mercury or water. The performance, however, was quite disappointing.

Extensive development brought about the present-day sodium cooled valve. It was found that if an aircraft valve is made hollow and filled with metallic sodium, it can be operated at power outputs never before attained with conventional valves.

The discussion emphasized that today much effort is being applied in developing better valves for the present-day high output aircraft engine. The search is for improved steels, better coatings, more durable insert seats, and longer lasting guides.

For higher performance, valves with better corrosion resistance and higher hot strength are required. The problem is made difficult by the fact that these materials must be compatible with guides and seats. There is under development today a material which shows much promise, an alloy of the Inconel family. This steel has better strength and stress elongation properties than the currently used valve alloy. It has been extensively tested by engine manufacturers and is presently undergoing flight tests.

It is axiomatic that airplanes must be operated with as low a fuel consumption as possible. This not only results in a reduction in fuel costs, but allows the flying of pay load in the place of fuel. This necessitates that the high cruise power be obtained with very lean mixtures. These lean mixtures in combination with leaded fuel have produced some exhaust valve problems. While it is recognized that lead compounds aggravate the valve problem, economic considerations demand that leaded fuel must be used and, therefore, the engine must be designed to digest reasonable quantities of tetraethyl lead.

The causes of valve failures can be many. Burning and breakage are some of the more serious ones. Burning can be the result of corrosive attack of the seat and faces of the valve and insert. This is being controlled by the use of coatings such as Stellite, Eatonite, Nichrome, and Brightray. Valve sticking can lead to failure and a possible solution is the use of rotation, either natural or induced.

Necking down of the stem under the head is attributable to erosion and corrosion. To minimize this failure, care should be exercised to insure that the valve is seating properly and does not leak. Both engine builders and valve manufacturers are exerting much effort on developing improved guide materials. Laboratory investigations and limited test stand operation indicate considerable promise toward this objective.

The importance of reduced valve temperatures with respect to corrosive attack by lead compounds was emphasized by actual test data. Laboratory tests showed that a 100 F increase in temperature caused a tenfold increase in corrosion.

It was emphasized that the valve seat insert can have a marked effect on valve life, both as a result of corrosion resistance and of hot strength. Hard facing with Eatonite or Stellite may greatly improve conditions of the seat of the valve, even though corrosion of the insert face cannot be detected. Seat inserts must be so fitted that they will remain tight in the cylinder head. Some cases of loosening have been reported; but it is believed that with the proper selection of base material and close control of the

A. T. Colwell, Thompson Products, Inc., leader of round table on service operational difficulties with aircraft engine exhaust valves and seat inserts.

press fit, it will not be a problem.

The importance of maintaining proper guide clearance was emphasized. When the guide clearance becomes large, the valve temperature goes up rapidly. One participant reported that increasing the spark advance resulted in a substantial increase in valve life. This is due to the reduction in exhaust gas temperature. However, if the spark is increased, is can be done so only if the fuel has sufficient antiknock quality to avoid detonation.

That engine builders are cooperating with valve manufacturers was evident by a historic description of the evolution of cylinders over the past 20 years. From cast cylinders, the trend has been to forged designs. Much attention has been paid to the finning. This has produced lower and more uniform cylinder head temperatures, particularly around the valve area. One of the latest cylinders employs bronze guides with a stainless steel tip. Another design incorporates the Ni-resist guide.

In summation, it was evident that much progress has been made in producing valves and seat inserts for the modern aircraft engine. Cooperative efforts between valve manufacturers and engine builders show promise of even better valves, seat inserts, and guides. This will make possible aircraft engines which can be operated under conditions conducive to maximum efficiency for long periods of time.

A 1950 Summer Meeting Round Table

Noise and Vibration Problems

Reported by H. R. Steding, Chrysler Corp.

Effective reduction of road noise in automobiles depends on mountings, insulation of the running gear, and panel insulation and damping, agreed members of this discussion group. No one of these factors is sufficient of itself, and it generally requires a combination of all three to produce a car with satisfactory quietness.

L. M. Ball,
Chrysler Corp., chairman of round table on noise and vibration problems.

One controversial issue was the distinction which should be made between "noise" and "vibration." It was argued that "noise" is airborne vibration while vibration is conducted through the structure. But there was a question as to where the line of demarcation should be drawn in respect to frequency. One opinion was advanced that vibration up to 100 cps should be classified as "vibration and those from 100 to say 10,000 cps as "noise." Others felt that the dividing line should be between 20 and 40 cps. It was argued, however, that both "noise" and "vibration" are objectionable and should be eliminated as much as possible.

It was observed that a high-pitched squeal is more annoying than a low-pitched vibration, regardless of the relative energies of the two vibrations.

As a demonstration, a tape recording was played of different engine cooling fan noises taken at 50 mph, with the recording microphone located where the driver's ear would normally be. A unanimous selection was made by those present of Fan B over Fan A, although it was explained that both fans had approximately the same total noise output. This method of comparison is considered to be much more effective and less time consuming than attempting to make frequency spectra analysis.

It was noted that there was a direct correlation between the amount of noise and the fan capacity

and horsepower, but that the quality of the noise could be quite different for different fans of the same output.

A question was raised as to whether fan blade damping would be beneficial in reducing noise. The opinion was expressed that fan noise is mostly air turbulence rather than fan blade resonance. It was also suggested that some "fan noise" may actually be engine noise reflected from the fan blades.

In discussing axle noise, it was agreed that the only effective approach to this problem is to isolate the axle, vibration-wise, from the rest of the car. One engineer left that the more circuitous the route the vibration must travel to get into the body, the more the noise will be subdued. However, another observer noted that the most important component of engine noise, next to that which is airborne, is the portion that is transmitted back through the propeller shaft to the rear axle and through the rear suspension to the body.

Another vibration problem discussed was that of "boom," defined as forced vibration of body panels. This is a difficult problem to attack because it seems to take very little to start some panels vibrating, even when loaded with deadener. Making the panel more rigid or more flexible will sometimes help for one driving condition, only to create a worse problem at some other driving condition.

Since the shape of the interior determines the basic acoustics of the passenger compartment, the vibration engineer is somewhat dependent on the stylists. In some cases, certain panels are so located and shaped as to be focussed at the driver, which accentuates noise from this source. Window glass may sometimes be a case of this kind.

The seat upholstery material is a very important factor in noise absorption in the passenger compartment. One observer spoke of the marked increase in noise which was encountered when a change was made from an open weave seat to a plastic type.

One problem encountered in recording noises in cars on the road for study in the laboratory is that of the binaural (two-ear) effect. The car passenger hears the noise with two ears, which gives him a sense of direction and distance; but a recording is usually made with only one microphone. A suggestion was made that the same kind of technique be applied in this work as in recording orchestra music, where a blend is obtained of the pickup from one microphone out in the auditorium with others which are located directly in front of the orchestra.

A question was raised as to why wire recordings of road noise, when played back in the laboratory, sound abnormally bassy. One explanation advanced is that the microphone discriminates against the higher frequencies. It was also pointed out that a listening room generally has better absorption of the high frequencies than of the low. The combination of these effects makes the recording sound excessively bassy.

When making comparisions of different noises in the laboratory, it was agreed that the time interval between should be very short —of the order of 10 sec or less—to obtain satisfactory comparisons on the play-back.

It was explained that current tape recorders cannot discriminate down to as little as 0.2 to 0.5 db due to variations in the thickness of the tape, its magnetic dispersion, and method of coating. However, comparisions which are usually sought are not nearly as fine as this.

A 1950 Summer Meeting Round Table

Vehicle Brakes

Reported by Howard K. Gandelot, General Motors Corp.

Safe vehicle stopping distances cannot be arbitrarily established, engineers at the vehicle braking round table argued, because it depends on so many variables . . . the driver, type of vehicle, type of operation, and the vehicle's braking ability.

"What constitutes a safe stop?" several asked, and found the answer less than simple. Many conceded that this largely involves the driver, and that both braking ability and stopping distance also should be considered. Further, one of the problems is the method for measurement.

One member of the round table stated that higher decelerating rates were possible for passenger cars than for trucks, tractor-trailer combinations and motor coaches because of vehicle loads and load distributions in the latter vehicles.

Another discusser pointed out that the distance in which a vehicle was stopped after the brakes were applied was not a true measure of braking. He introduced the term "stopping sight distance," which

P. T. Brantingham, International Harvester Co., leader of round table on brake testing, procedures for determining performance and wear, and what constitutes a safe stop.

includes a measure of the driver's perspective ability and his reaction time plus the braking ability of the vehicle.

A member with long experience in braking systems for heavy-duty vehicles explained that actual stopping distance is not necessarily a measure of the safety for motor coach passengers; braking equipment set to provide high rates of deceleration with normal pedal applications could result in passenger injury. He mentioned the experience record of one operation, where coach passenger injury complaints were practically eliminated by adjusting the air brake controls for decreased stopping ability.

Left Foot Braking

One contributor mentioned the possibility of positioning the brake pedal for left foot operation on passenger cars equipped with automatic transmissions. The principal comments on this were that: (1) such a major change for the motorist in foot control location would require a long transition period, and (2) that many drivers of automatic transmission cars are presently operating the brake pedal with left foot, especially when in city traffic, which may be a step toward relocation of the pedal.

A 1950 Summer Meeting Round Table

Vehicle Leasing

Reported by Robert Gardner, Lever Bros. Co.

Vehicle leasing is economical for small fleets having no qualified fleet operator, fleet men at the Round Table seemed to agree. There were few other points on which any unanimous agreement was indicated.

One vehicle-leasing company executive saw little benefit in leasing for a fleet operating locally under constant supervision. He considered it suitable chiefly for small fleets, but observed that a scattered fleet really is a group of small fleets. Small fleets also were said to gain from leasing because they don't have the know-how to buy automotive equipment.

Fleets with few trucks find leasing advantageous due to availability of spare units during peak operations. And they lose no time for maintenance. Some fleets, it was reported, operate their own vehicles in some locations and lease equipment in other areas. One operator said his company leased cars for tough service only.

"How small does the fleet have to be for leasing to be beneficial?" asked several men. Actual number of vehicles depends largely on the type of operation, came the reply. However, it was agreed that a six to 10 vehicle fleet is tough to operate if the trucks are far-removed from maintenance facilities.

Discussers made it clear that salesman ownership of cars for business use is leasing. The company finances the employee in one way or another. But adequate reimbursement must be made for employee-owned cars. Otherwise, the employee's salary is really being cut and for this reason the plan is sure to fail.

Some argued passenger car leasing becomes economical beyond 12,000 miles per year. They saw leases as good insurance for the operator against inflation in operating cost and equipment price drops.

An eastern fleet man noted that operating costs are low with new vehicles, but rise with age. He felt leasing costs were so high that a fleet couldn't gain any benefits from new vehicles.

Release of capital by leasing trucks was labelled hypothetical. Said one engineer, the equipment itself is security when borrowing money to buy automotive vehicles. Thus the automotive loan doesn't affect borrowing power for financing other phases of the business.

Cost-per-mile operating figures were reported to vary considerably, so that basis for agreement could not be reached. For example, noted a truck man, a truck operating 15,000 miles per year in Chicago

might cost $7\frac{1}{2}$¢ per mile to maintain, while the same truck operating 75,000 miles per year over-the-road might cost only $2\frac{3}{4}$¢ per mile.

One fleet operator presented his cost figures, which showed he saves $231 per year per vehicle by owning the cars. The costs, based on operating the car 20,000 miles per year, are:

Interest	$ 35
License	12
Gas	347
Oil	18
Tires	25
Repairs	75
Grease	18
Storage	100
Washing	30
Tolls	10
Meters	20
Insurance	41
Depreciation	250
Taxes	30
Total	$1011

Cost of leasing this car is $740 per year. In addition, the operator incurs the following expenses:

Gasoline	$ 347
Storage	100
Tolls	10
Meters	20
Insurance	25
Total	$ 502

Thus, total expense for operating the leased car is $740 plus $502, or a total of $1242. Owning the car costs $1011 annually, which saves $231 over leasing.

Akin to leasing is a guaranteed maintenance and finance plan discussed. A truck man said that an accumulation of 30 million miles of experience made it possible to find truck weaknesses and to improve accessibility. Because this plan maintains an even work flow into the shop, it lowers truck maintenance costs.

Round table participants agreed that while vehicle leasing-versus-owning discussions were not conclusive, further discussions will be derived from this session.

H. L. Willett, Jr., Willett Co., leader of round table on leasing of vehicles in the long-range transportation problem.

A 1950 Summer Meeting Round Table

Diesel Filtration Problems

Reported by Sydney L. Terry, Chrysler Corp.

The design of oil filters has been too casual in relation to their importance in determining overall diesel engine life and performance, round table participants agreed. Filters also aid conservation of one of our most vital short supply natural resources.

Representatives from each of the four groups chiefly interested in diesel lube filtration told what their problems are and what they're doing about them. These four groups are:

1. The engine manufacturer,
2. The lubricant manufacturer,
3. The filter manufacturer, and
4. The diesel engine user.

One diesel engine manufacturer started out 15 years ago by using full-flow metal disc-type strainers with his engines. Disc spacing was 0.0015 to 0.003 in., depending on the service conditions. This full-flow type was succeeded by a by-pass system with paper-type elements. Since the advent of

H. V. Nutt,
U. S. Naval Engineering Experiment Station, leader of round table on lubricating oil filters and filtration problems in diesel engines.

detergent oils, the by-pass system of filtration has proved unsuccessful, principally because the color of the oil is no longer an indicator of the condition of the oil. A very small percentage of soot after reacting with the additive will leave very black-appearing oil which is, however, still in healthy condition.

This evidently causes the user to leave his filter element and his oil in the engine for too long a period; and many cases of excessive bearing and cylinder wear were reported.

This manufacturer has now switched back to the full-flow type filter, using paper elements which greatly reduce the size of filter required to handle the large oil flows. A bypass check valve is provided which allows direct oil flow around the filter when the pressure exceeds 15 psi. There is no other bleed hole through the filter. A very substantial improvement in engine performance has been achieved by this filtration system.

Oil Life Doubled

Another user of the paper-type, full-flow filtration system claimed that the full-flow filters despite their additional cost, actually accrued a saving by doubling the useful life of the oil. This doubled life was determined by a laboratory analysis of the oil made by the supplier.

A manufacturer of paper-type full-flow filters stated that tests had shown that a full-flow type filter could replace a bypass-type filter of the same size and double the life of the oil under the test conditions. This, of course, does not refer to the state of the additives in the oil, but rather to the type and amount of abrasives and other matter being circulated in the oil.

There was also the feeling, strongly expressed by several, that full-flow filters yield a heavy advantage not always measurable by the condition of the oil. This advantage stems from the fact that the time of circulation of harmful particles is much less for the full-flow than for the bypass type. Thus, although the condition of the oil might be the same at the end of the run, engine wear might be greater for the bypass-type filtration system because of the longer time of circulation of the abrasive particles finally filtered out.

Bypass-type filtration was defended by a filter manufacturer. Field tests were cited which, while incomplete, seemed to indicate a remarkable efficiency for the bypass-type of cotton waste filter for a time. The tests, however, showed that after a certain point the petroleum ether insolubles (PEI) mount very rapidly, as well as rise in percentage.

One reason given for this maximum carbon content was that the oil viscosity had now increased to the proper maximum allowable for splash lubrication.

Resulting discussion indicated that:

1. Different methods of analysis may give entirely different resin percentages.
2. Oil additives, or some percentage thereof, may be mistakenly included among the resins.

It was urged that round-table discussers attend the Chicago meeting in November, sponsored by the SAE Diesel Engine Activity, to discuss the question of "Analysis of Used Heavy-Duty Oils in Service." Concensus of opinion had it that diesel oil filtration would be facilitated if a common system of evaluating the condition of the filtered oils were established.

What Oil Men Want

Lubricant manufacturers held the position that a filter should:

1. Remove as much abrasive as possible as soon as possible.
2. Remove as little additive as possible.
3. Remove as much soot as possible for as long as possible.

The amount of soot resulting from diesel operation varies greatly with the type of engine, operation of the engine, and the point of life of the engine. One manufacturer stated that his engine deposited soot 10 times as fast after 5000 hr as it did after 500 hr of operation. Increased blowby is chiefly responsible for this increase in soot formation. Other conditions which promote soot formation are the amount of sulfur in the fuel and low-temperature operation.

Lubricant men agree with railroad diesel operators that lubricant analyses do not correlate with each other and do not necessarily indicate the condition of the engine. The percentage of additive remaining in the oil is preferred by one lubricant manufacturer as the means of evaluating diesel oils.

Detergent oils are apparently here to stay. Oil men accordingly have changed their position as to what function should be performed by the filter. They agree that the filter should take out foreign abrasives, most of which have been admitted by the air filter. They further insist that the filter take out as little additive as possible. All filters take out some additives, but most filters cease to remove additives after a fairly short time.

Filter elements listed in the order of their additive removing qualities are:

1. Wood pulp
2. Cotton waste
3. Fuller's Earth

Some filters remove so much additive that they are a net liability, in the opinion of some of the lubricant and engine manufacturers. Engines using these filters would be better off without them when using heavy-duty oils.

Minimum size of particle which should be removed was said to be 3 to 5 microns. Engines with filters passing particles up to 3 microns in size show very low wear rates, of the order of 0.0005 in. per 1000 hr. A filter does not always prevent sludging. In fact filters will pass soot when detergent oils are used, and intermittent operation may still allow sludging.

Perhaps the most serious problem with the new detergent oils, from the diesel engine user's standpoint, is the lack of a simple method for determining when he needs to change both oil and filter elements.

All agreed that filters of the proper type were desirable. But developments in the paper type of full-flow filter and in detergent oils have made the proper mating of filter, engine, and oil an entirely new and challenging problem.

A 1950 Summer Meeting Round Table

Fatigue and Service Testing

Reported by Howard K. Gandelot, General Motors Corp.

Two big problems face engineers shooting for extended parts life, observed automotive designers. They are: (1) truly simulating service usage in lab and field tests, and (2) extracting design improvements from such test results.

Discussion focussed on the loading type of fatigue testing of axles for heavy-duty vehicles such as large trucks and motor coaches. Some axle components are life-tested with applied loads in the order of 2 to 3g up to a million cycles. Certain axle gears are life-tested at torque loads ranging to 9000 lb-ft. One problem in test work of this nature is how to put the data back into the design of the parts, agreed several engineers.

Testing components for 25,000-lb vehicles, driven by 250-hp engines, by simulated service shock loading, it was pointed out, requires test forces that most laboratory equipment cannot withstand—at least for very long periods.

One panel discusser presented a novel method developed for testing a new truck axle design which had been fabricated by a new method. The method consists of the following steps:

This housing was given a brittle-lacquer stress coating and then was hydraulically loaded at the spring seats to obtain a definite stress pattern. Then strain gages were located at the points of stress concentration, a 100% overload was applied, and gage readings taken. Then the axle was installed in a truck and driven over an obstacle test road with sharp rises and drops which produced shock loads representing load factors 2.75 times the static load. The strain gage readings were taken by means of a consolidated oscillograph.

Another panel member spoke in favor of fatigue

A. F. Underwood, Research Laboratories Division, GMC, leader of round table on fatigue and service testing of automotive parts.

testing procedure using S/N curves to reduce test time and cost; this technique supplies the designer with approximate, but quicker answers. Such procedure involves consideration of the fatigue limit and the effect of stress concentration. Scale effect also must be considered in case actual parts are large and the testing is being done with scaled-down samples.

In discussion concerning connecting rod and piston pin failures, several connecting rod designs were shown to illustrate how a reworked rod design with reduced cross-section area overcame fatigue failures experienced near the lower end of the original design. Regarding piston pins, it was agreed by several that piston pins with "straight-through" holes were preferred over the tapered hole design.

Interesting information also was revealed on the fatigue effect of chromium plating. One of the panel members cited investigations of parts baked after plating, to relieve resulting embrittlement. This produced an increase of up to 95% of the normal endurance limit of the unplated part (using on 850 F baking temperature), compared to a 60% value as plated.

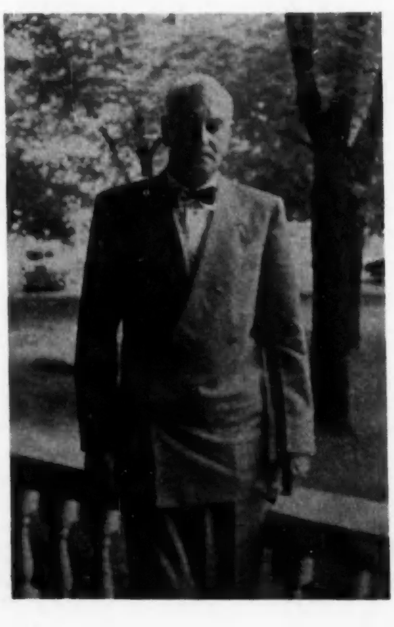
A 1950 Summer Meeting Round Table

Multi-Purpose Bodies For Passenger Vehicles

Reported by R. L. McWilliams, General Motors Corp.

Station wagon demand was seen splitting into two growing, but distinctly different, markets—one for utility vehicles and the other for luxury jobs. Body men predicted continuing price reductions in the utility class due to the all-metal construction.

The first station wagon as such was produced in 1929 and the sales effort was directed toward country clubs and estates as a utility vehicle. It was as attractively styled as a passenger vehicle. Industry sales up to the present time have been low, when expressed as a percent of total production; however, sales of station wagons have steadily increased percentage wise.



F. S. Spring,
Hudson Motor Car Co., leader of round table on multi-purpose passenger vehicle bodies.

The small but increasing demand for station wagons has reached a point where production of the conventional all-wood or wood-and-metal bodies has become a problem. The quantities of station wagons produced has required production tooling. This combined with the relative scarity of fine woods has led to the all-metal station wagon or suburban.

It was felt that this development of all-metal construction will reduce the price and still further increase the demand for such vehicles. This reduction in price is indicated by comparison of present costs. Car "A," an all-wood body, is 52% higher in price than its companion standard four-door sedan; Car "B," an all-steel body, is only 18% higher in price over its companion standard four-door sedan.

In analyzing the reason for the increasing demand for station wagons, the following observations were made:

1. Originally it was built as a luxury vehicle, which would serve as a passenger car for general purposes.
2. In certain areas, and for a period, it was a luxury vehicle appealing to those who could afford a "second" car.
3. Its utility as a passenger car and a cargo carrier has been recognized by small businesses, salesmen, farmers, and others who need a vehicle to perform both functions, but do not want or need two vehicles.
4. Restrictions which prevent commercial vehicles from using boulevards and congested areas

permit utilities, tradesmen, and others to serve such areas by using station wagons.

Station wagon or suburban usage now appears to be following two distinct paths. The first is the increasing use of such vehicles as strictly dual purpose vehicles, and the second, that of a luxury vehicle with its utility playing a minor role.

These two uses, prophesied body men, will probably have the following effects:

1. Increase in production with still further increase in percent sales of station wagons to total sales. Sale of light commercial vehicles might be affected.
2. The station wagon purchased strictly as a dual purpose vehicle will be of all-steel construction, whereas the essentially luxury vehicle will probably move into the higher price class and may well continue the use of wood and metal construction.

A 1950 Summer Meeting Round Table

Higher Voltage Systems for Cars

Reported by Sydney L. Terry, Chrysler Corp.

Need for a higher voltage ignition system takes on increasing urgency with the trend to higher compression engines, according to engine and electrical men at the session.

One engine manufacturer, who has taken the initiative in this trend, showed the ignition performance curve of an experimental 8 to 1 compression ratio engine with used spark plugs of 0.030-in. gap. Available voltage with full electrical load and voltage required with used spark plugs were both plotted against car speed. At no point was the margin of safety over 5%; and at 33 mph and all the way from 62 to 100 mph, the margin of safety was 1% or less.

A second series of curves showed the effect of compression ratio on spark plug voltage requirements. The present 6-v electrical system was taken as the base, and a spark plug gap of 0.030-in. gives marginal performance for an 8 to 1 compression ratio.

The same plugs require a minimum of 8% more plug voltage at 10 to 1 compression ratio and 23% more plug voltage at 12 to 1. If the plug gap is increased to 0.040-in., the voltage requirement is increased 10% at 8 to 1, 33% at 10 to 1, and 51% at 12 to 1. A 0.020-in. gap plug requires 96% of the present supply for 8 to 1 compression ratio, 100% for 10 to 1, and 5% additional capacity at 12 to 1. These data clearly demonstrated both the need for higher plug voltages as compression ratio increased, and the very important effect of spark plug gap.

Two methods of increasing spark-plug voltage were examined by this manufacturer—the double-coil, double-breaker system and the 12-v electrical system. The 12-v system was chosen because of its greater simplicity—both for manufacturing and servicing—and its lower cost.

Ability to fire fouled plugs is an important consideration in evaluating the new system. Curves were presented which showed that the 12-v system would not only nearly double the coil voltage of the 6-v system with 3 megohms shunt in the system, but would give 25% more voltage with 1 megohm shunt. These figures were all at 4000 engine rpm.

Further data were given showing the permissible minimum value of plug shunt resistance, or the

Herman Hartzell, Delco-Remy Division, GMC, leader of round table on higher voltages for automobile electrical systems.

amount of fouling allowable. With the 12-v system, shunt megohms as low as 0.37 to 0.45 were permissible for compression ratios ranging from 8 to 1 to 12 to 1. But with the 6-v system, the ignition system failed if the shunt megohms dropped below 1.50 for an 8 to 1 compression ratio, or below 1.75 megohms for 12 to 1.

Fouling limits established on 12 spark plugs in different states of cleanliness showed that a fairly clean, but fouled, spark plug had about a 14 megohm shunt resistance at 4000 hpm, while a badly fouled plug dropped rapidly with speed to 0.5 megohm at 2400 engine rpm and shorted out completely.

All of this data emphasized that:

1. Higher spark plug voltages are required as compression ratios are increased.
2. The present 6-v electrical system is marginal for the 7.5 to 1 high compression automobile engines now being produced.
3. The 12-v electrical system would probably supply satisfactory spark-plug voltage for compression ratios up to 12 to 1.

Higher Voltages in Use

Another engine manufacturer there pointed out that the 12-v electrical system is in use today in a number of heavy duty applications. Thus, if present-day 6-v ignition is not going to be satisfactory for future engines, the 12-v system is the best way to go.

The British have standardized on 12-v electrical systems, and cite a number of advantages of the 12-v as compared to the 6-v system. In fact one British company claims that the 12-v system is actually cheaper than the 6-v system, the extra cost of the battery being more than offset by the lighter and cheaper 12-v generator and starter.

An electrical equipment manufacturer did not agree with this latter claim. He presented a detailed comparison of 12-v and 6-v starting motors in the 4½-in. diameter size. He showed that for the same battery voltage output, the 6-v motor gave better starting torque, although maximum horsepower delivered was about 9% less. Also more amperes were required for the 12-v starting motor, largely because of the greater commutation losses.

The 12-v motor will cost more than the 6-v because of the greater number of turns required and because of the extra insulation. Performance of the 12-v motor is definitely not as good today as that of the 6-v motor, several opined; but they agreed that concentration on the 12-v motor will improve it to the point where its performance will match the 6-v motor.

The point was also made that the characteristics of the smaller engines and higher cranking speeds required in English practice require starting motor characteristics which tend to favor the 12-v motor. Furthermore, an analysis of the English 12-v starting motors shows performance characteristics no better than 6-v motors of comparable size made in this country.

The 12-v generator would deliver about 15 to 20% more output than the 6-v generator of comparable size because of the ability of the regulator contacts to handle more field excitation watts at the lower current.

A tabulated comparison of storage batteries for 12 and 6-v systems was presented. See Table 1. The standard 100 amp-hr 6-v battery was taken as a base, and compared with a 12-v battery of equal voltage, and a 12-v battery of increased voltage to improve starting performance.

Because an equal cost battery (for 12-v systems) would give less than 40 amp-hr for a 20-hr capacity and less than 240 amp, it was considered inadequate.

The cost of wiring the 12-v system would be less than that of the 6-v system. Size of wire is dictated by one or more of three critical factors:

1. Voltage drop,
2. Maximum overload current capacity without overheating, and
3. Mechanical strength.

Assuming the same current in the ignition circuit, two-thirds the present current in the starting system, and one-half the present 6-v current in the lighting and other circuits, it was found that a cost saving of 10% to 15% could be made on the wiring. Most of the wire sizes could be cut down to one-fourth their present area on the basis of voltage drop. This is the equivalent of a change from 12 to 18 gage.

While 16 gage is regarded as the minimum allowable size for the present 6-v system for mechanical strength, it was assumed that 18 gage could be used in the 12-v system. This assumption was justified by the fact that mechanical stresses of the smallest wire of a group frequently depend on the size of other wires in the harness. Maximum temperature rise considered allowable was 40 F, or 150 F maximum temperature at 110 F ambient carrying full current continuously.

Discussion turned to 12-v lamps. Pictures shown of the filaments for 12-v and 6-v lamps in 1 cp, 32 cp, and 35 to 45 watts sealed-beam headlights made it clear that the 12-v lamp filaments were larger, more costly, and considerably more fragile.

For a given wattage or candlepower rating, the 12-v filament wire is twice as long as the 6, but has half the cross-sectional area. Since the light source is larger for 12-v filaments, the optical properties are not as good for headlights, fog lights, spot lights, and signal lamps. The 12-v filament must be operated at lower temperatures because of its higher surface to volume ratio, but its end losses are less.

Overall efficiency of 12-v lamps is about the same as that of 6-v lamps. Assuming the same volume of production, the cost of 12-v lamps will be about 15% more in the 1-cp size, 10% more in 32 cp size, and

Table 1—Comparison of Batteries for 6-V and 12-V Electrical Systems

20-hr Capacity	6-V Battery 100 amp-hr	12-V Battery 50 amp-hr	Super 12-V Battery 67 amp-hr
Weight	100%	105%	132%
Volume	100%	109%	135%
Current	600 amp	300 amp	400 amp
Cost	100%	130%	165%

25% more in 45 watt size. Performance of the 12-v lamps will not be as good. There would be more premature failures for mechanical reasons.

On the basis of the relative costs presented, the cost of the components discussed for 12 v of the size to give performance equivalent to that of the current 6-v equipment would be from 5 to 8% higher. If ignition requirements call for the use of a two-coil 6-v ignition system, then equivalent performance can be obtained with the 12-v system for 2 to 5% less.

Other means of avoiding the undesirable increase in voltage were then discussed. As much spark-plug gap as possible is desired by the engine manufacturers. Increased gap allows them to use leaner mixtures at part throttle, with a resultant increase in fuel economy. A 0.30 to 0.35-in. gap is the compromise reached with the present high compression engines and 6-v electrical system.

Resistor spark plugs show lower gap growth, which alleviates the situation somewhat.

Tests on supercharged engines indicate that spark-plug voltage requirements are materially reduced from those of normally aspirated engines, even with higher compression pressures.

There was some discussion of 8 and 10-v systems. But the objection to nonstandard lights and radio tubes was cited. It was also felt that all of the 12 volts would be needed to assure adequate spark-plug performance for future high compression engine designs.

It was suggested that some attempt be made to use the excess generator capacity at high speeds, since it is here that the spark-plug voltage requirements first become marginal.

Higher Voltage Problems

Radios will be a little more expensive unless regulation is improved with the 12-v system. Arcing problems, welding across shunt circuits, and electrical burns in servicing operations will be more common and more severe with the 12-v system, it was forecast.

Higher compression engines require higher voltage electrical systems. Ignition performance or present new design engines is marginal. The 12-v system appears to be the best solution of the problem today; but many disadvantages, including a 10% to 15% cost penalty, serve to accelerate the search for a better solution to this knotty problem.

A 1950 Summer Meeting Round Table

Automotive Seating

Reported by R. L. McWilliams, General Motors Corp.

Round table discussers recommended that an SAE group be formed to investigate and develop standards on testing, nomenclature, and measurement of automotive seats. They also evaluated new seating materials and constructions, which give promise of greater seating comfort.

All agreed that lack of standardization called for cooperative effort. Seats, said body engineers, are a particularly salient phase of safety, since driver comfort and vision are controlled by seating comfort and driver eye level. Both these factors depend on seat design and construction.

Seats are designed for average size individuals, participants noted, yet no one is completely satisfied that we have determined the average size. Body engineers were referred to two basic references on human dimensions. They are: (1) AAF Technical Report No. 5501, "Human Body Size in Military Aircraft and Personnel Equipment," an unclassified report, available from the Air Materiel Command, Wright Field, Dayton, O., and (2) "The Use of Scale Mannekins," in the December, 1949, issue of the University of Iowa student publication, "Transit."

Development of two test methods was referred to the proposed SAE subcommittee. First is a method of measuring loaded contours of seats, and the second is a procedure for testing seat pad materials.

Investigations were reported which showed the relationship between seating comfort and driving safety. One study demonstrated that chassis vibrations could affect driver fatigue. It showed that frequencies of about 120 cpm at amplitudes of 1/4 in. aggravate driver fatigue. This emphasized the need for seats to flex constantly a certain amount to give maximum comfort and to prevent numbing of leg, thigh, and back muscles.

Discussions of seating design and construction specifics brought out conflicting opinions on the merits of a cotton pad between a foam rubber cushion and the trim cloth. Some said such construction is cooler. Others argued that the plain foam rubber cushion has better heat-dissipating qualities than a cotton pad on foam rubber. Absorption of perspiration rather than heat dissipation is the real

problem, this latter group was told. Certain tests reported showed little difference in heat rise between the two types of construction.

All agreed that the degree of thigh and buttock envelopment is a bigger factor in heat rise than cushion materials. Another element, from a production standpoint, is that trim cloth with latex backing is difficult to pull over foam rubber.

Seat adjuster mechanisms stimulated interchange of ideas, with easy forward and backward motion plus positive locking emerging as the prime requisites for these devices. Some degree of vertical adjustment and change in seat angle was seen desirable in certain applications.

Designers said that for commercial vehicles, the most comfort stems from independent adjustment of seat and back. This was said to be particularly true for over-the-road trucks and buses, involving long driving stretches. Buses operated by more than one driver on a single run require adjustable seats. Flexibility in seat and back adjustments, it was said, promotes safety through comfortable posture and lessened fatigue.

Several advantages were seen for the zig-zag type of spring construction over the coil design. First, trim height variations can be reduced, according to the experience of one engineer. Second, zig-zag springs have made possible more toe room and space under seats. However, comparable toe room was reported possible with recent developments in coil spring type seats.

Toe pockets in front seat construction will be continued, round table participants were assured. This practice adds wheelbase, as far as passenger room is concerned. Moving the rear seat forward of the rear axle gives rear-seat passengers a better ride, and toe pockets make this possible.

Pneumatic seats were mentioned as one development under way. Experimental designs were reported giving excellent service.

J. D. Caton,
Chrysler Corp., leader of round table on current automotive seating problems and designs.

A 1950 Summer Meeting Round Table

Automotive Suspensions

Reported by H. Richard Steding, Chrysler Corp.

W. E. Burnett,
Ford Motor Co., leader of round table an automotive suspensions.

Automotive suspensions will help produce good ride if they are happily married to allied items, such as tires and steering, maintained passenger car engineers.

How to Reduce Squeal

In discussing tire squeal, it was reported that anything done to help keep the tires vertical with respect to the road also tends to reduce tire squeal. Squeal comes in at a definite slip angle; and any change in camber will also change the slip angle at which squeal appears. Tire men stated that within the range of compounds acceptable from the standpoint of wear and other factors, the particular compound used has a negligible effect on squeal.

It was agreed that while a heavy unsprung mass is desirable in giving a smoother ride at low speeds

over moderately rough roads, a lighter unsprung mass is better from the standpoint of keeping the wheel on the ground at high speeds. A proper balance between all the factors involved must be reached in suspension design problems such as these.

The question was asked whether a lower unsprung mass would be desirable if there were available a tire of less hysteresis and lower rate. The answer offered by tire men, on the basis of actual experience, was that such a tire would not be desirable because while it would tend to reduce road noise and harshness, it would also have less stability.

It was stated that tire tread designs have only a limited effect on handling characteristics.

In tracing trends in steering, it was pointed out that the center of gravity of cars has been moving forward with respect to the rear wheels, which in itself has the effect of increasing the understeering characteristic. Consequently, tires have had to handle more cornering force. This can be and has been offset to a certain extent by the geometry of the steering and suspension systems.

A 1950 Summer Meeting Round Table

Cooling System Problems

Reported by A. L. Pomeroy, Thompson Products, Inc.

The trend toward higher pressure cooling systems was the focal point of this session. While benefits of pressure cooling are well known, their application introduces some problems, which discussions pointed up.

Methods of testing pressure caps are currently under study. At present, there does not appear to be any quick and reliable means of determining whether the cap is operating at its design point. The crying need is for some procedure which can be conducted by the ordinary service station attendant.

Cooling system pressures in the order of 15 psi are under investigation. However, their application may necessitate design changes in radiators. At present, radiators are capable of withstanding 5 to 10 psi. Further increases will probably require structural improvements. Staybolts may have to be reinforced.

Another matter which must be investigated very carefully before higher pressure systems can be released is whether pump glands and gaskets are capable of operating in the 15-psi range. There has been some experience with 15-psi systems and results have been encouraging. However, these applications are limited and more work must be done. Some engine builders introduced hose changes and pump redesigns when the cooling system pressure was increased.

The problem of personnel hazard with higher pressure systems was reviewed. With the present 5 to 7-psi system, very few cases of scalding and burning have been reported. Serious consideration is being given to the design of caps which will allow a slow blow off. Essentially, this consists of a double latch which introduces a stop before the cap is removed from the radiator. This delay allows controlled blow down, thereby preventing spill-over or steaming.

In general, it was felt that at 15 psi the difficulties were not insurmountable. However, at from 20 to 25 psi the scalding and burning problem will require considerable attention.

Data were presented which showed that improve-

J. R. Holmes, Harrison Radiator Division, GMC, chairman of round table on cooling system problems.

ments in radiators from the standpoint of eliminating restrictions are in order. It is particularly important to concentrate on outlet connections. Designers must more carefully consider the available pump suction and must relate radiator restrictions to the pump suction. Again, the plumbing external to the radiator can stand cleaning up, particularly turns. Better coordination between the engine builders and radiator manufacturers was urged.

One of the problems which faces engineers is the large number of radiator design specifications. Some method of standardization appears desirable and it was the feeling of some that an SAE-sponsored specification would be very helpful. The one method which many use is the "air-to-boil" standard. However, it is not uncommon to find the idle requirement to be limiting.

There are indications that, because of automatic transmissions, more radiation area will be required. This is not necessarily due to the cooling requirements of the transmission, but rather the change in balance between engine speed and car speed. For example, these transmissions can permit an engine torque of 40 mph at a car speed substantially lower. This results in reduced fan speed and lower ram air. Modern highways are also changing cooling requirements.

Fan shrouds, if properly designed, can effect improvements, particularly at low speeds. It is quite probable that more use will be made of them in future vehicles, round-table discussers predicted.

Leakage of gas into the water jacket and aeration of the system are other troublesome items which must be given attention. While independent drives for fans and pumps make possible improved cooling systems, their complexity and added expense cannot be justified except in limited cases.

Sealed cooling systems look attractive, but introduce new pump design problems. Again, they are predicated on the use of one cooling solution for both summer and winter. This brings about the question regarding the permanency of cooling solution and antifreeze. Data obtained by many investigators showed that the permanency of the freezing solution is dependent on many factors, such as operating conditions of the engine and many others. The corrosion inhibitors in use today can spend themselves and must be replenished. With the sealed system, this presents quite a problem.

Future vehicles will very definitely incorporate pressure cooling systems. Because of reductions in radiation area and gains in efficiency, the peak operating pressures will increase in the order of 15 psi in the very near future. Secondary benefits, such as reduction in engine wear and sludge because of better temperature control, will also be made possible by better designed cooling systems. However, the attainment of these objectives introduces a number of problems which must be solved through the cooperation of engine builders and radiator and cooling engineers.

A 1950 Summer Meeting Round Table

Engine Wear

Reported by Harold Myers, Perfect Circle Corp.

Compatability of materials bulked large as an engine wear factor at round table discussions on engine parts life. Engineers argued relative merits of materials in terms of test and service-backed data . . . chrome plate for bearings and piston rings, cast iron versus steel crankshafts and camshafts, tungsten carbide tappet faces, and Ni-resist piston inserts.

Big job for the engineer, most agreed, is to find a combination of materials that get along with each other. Sometimes hard materials satisfy the wear prevention goal; often soft materials turn the trick.

Soft materials often are used in the presence of abrasive, since they are able to imbed the abrasive particles and keep them from remaining an active wear source. Examples of this are the connecting rod and main bearings used in diesel engines. If it is not possible to use a soft material, then a hard material may be used with pockets or holes to provide a space for imbedding abrasive particles. If we cannot imbed the particles, then we must use hard materials.

When two materials are rubbed together they, by nature, want to stick—not separate, as we would like to avoid wear. This sticking, or interlocking, results in surface removal of material and ultimate wear of the part.

Often we want rapid parts wear to provide mating between two moving pieces. In such cases, we quite often use low melting point, soft materials as a coating on a harder material to provide rapid wear during the seating-in process, and reduced wear rate after proper seating. Such materials as phosphate coatings also accomplish this early mating or

seating-in process. Interrupted surfaces—such as those produced by fairly rough honing, turning, or grinding—serve a similar purpose in providing a rapid wear-in period during early operation.

Chromium has been used successfully in many places as a bearing material, discussion revealed. On wrist pins, connecting rod journals, and other similar applications, where full-fluid lubrication is possible, chromium's high hardness and abrasion resistance work to advantage. Many other materials may be used as successfully. On top piston rings, valve stems, or valve guides, chromium's ability to function without scuffing, despite extremely poor lubrication, is important.

Chromium has not been successful as a wear-resistant material on cam followers. Where chromium was attacked by the lubricating oil, it did not function as satisfactorily as did silver, which had greater resistance to chemical attack of the lubricant.

One engineer cited an example where a four cylinder $4\frac{1}{4} \times 4$ in., 199-cu in. displacement engine was run, using integrally cast-aluminum cylinders for three pistons, with the fourth cylinder being equipped with an iron liner. The pistons were fitted with 0.0025-in. clearance and all top rings were chromium plated, with the corners chamfered to prevent digging in. The engine was run 100 hr at full throttle, 145 bmep, at 2,500 rpm.

After this run, the engine showed less wear on the aluminum cylinders than on the one iron cylinder. One more trial was run with the pistons fitted to 0.016-in. clearance, but this proved unsuccessful since the piston cocked and cut into the cylinder. The engine was never placed into production, although this discusser believed such an engine entirely feasible. The production engines were equipped with thin steel liners pressed into the aluminum block. The aluminum was a 142 alloy.

Another engineer disagreed with the theory that soft bearing materials were used to imbed abrasive particles. He believed the bearing materials permit plastic flow to obtain better load distribution between bearing and journal. This prevents high unit pressure areas which would wear away rapidly. One panel member told of a grid bearing used in tank service during the war quite successfully. This was a synthetic copper-lead bearing, made by rolling 3600 indentations per sq in. into a copper sheet, and then filling these indentations with a lead-base babbitt material. This bearing worked especially well under dirty operating conditions.

Electrographic spot test analysis revealed that the depressions carried particles of iron and copper imbedded in a soft matrix. "Dirt collected in the 'mud holes' instead of on top of the 'rocks,'" said one engineer.

It was reported that some English diesel engines have shown chromium plate to give poor wear when used with high sulfur fuels. A discusser suggested that the wear may have been from corrosion and that the nature of the plating may have been responsible for the results. A fairly porous plating may absorb corrosive materials into the pores and thus be attacked more quickly than plating that's less porous.

An American engineer working on diesel engine design reported that the principle use of chromium by his company was in top compression rings. Cylinder liners plated all over perform satisfactorily against unplated rings; but it costs less to use the plating on the rings only. This same engineer also reported some experiences of high wear with corrosive fluids from other sources than high sulfur fuel. He believed that corrosive substances in lubricating oil or trace elements in the intake air, along with cold jacket temperatures, might be responsible for the high wear rates.

C. G. A. Rosen,
Caterpillar Tractor Co., leader of round table on wear of piston rings, cylinders, camshafts, and tappets.

Still another engineer said he found the four-cycle diesel engine shows better improvement with chrome-plated piston rings than two-cycle engines. Under high temperature conditions, cracking has been observed on the surface layers of chromium plate. These surface cracks might permit the penetration of corrosive fluids, it was conjectured, and thus introduce considerable corrosive wear.

The problem of the single material being asked to meet variable conditions received attention. For example, in one case the cam faces on cam shafts worked satisfactorily with phosphate coating; but oil pump and distributor gears did not work as well with phosphate coating as with a thin coating of copper. Thus, the single-material cam shaft is asked to meet two distinctly different wear problems.

The general belief that copper-lead bearings work successfully only on hardened crankshafts was debunked. In the experience of one man, a soft cast-iron shaft operating against copper-lead bearings gave better bearing life than when the same bearings were operated against hardened cast-steel shafts.

"Would the results have been the same had the copper-lead bearing test been run against the same material at various hardness levels?" questioned a discusser. One engineer felt it was not fair to compare hardened steel against soft cast-iron, and then to generalize that copper-lead bearings could be

used successfully against soft materials. He believed that copper-lead might work successfully against soft cast iron, but fail miserably against unhardened steel.

It was reported that the crank tests run on the soft iron were operated under no load conditions at 4000 rpm, and that some 25 tests gave consistently agreeable results. In all cases, the soft cast-iron shaft showed better bearing life than the hard steel shaft. In fact, the lead flash in many cases had not worn off the bearing.

Still another engineer believes that since cast iron containing graphite has an interrupted surface and better emergency lubrication properties, it would definitely show an improvement in wear over a hardened steel shaft, even though used in the soft condition.

Discussion turned to a comparison of cast-iron versus steel cam shafts. One engineer reported that steel requires a different surface than cast iron. He found hardened steel cams best with cast-iron followers, although cast-iron followers on cast-iron cams also worked satisfactorily. Steel on steel, in his experience, was entirely unsatisfactory for cams and lifters.

At one time during a strike, chromium was used on the cams against steel lifters. This also proved unsatisfactory. Other coatings were also tried, but the effect was lost as soon as the coating wore through. Oil pump drive gears, according to this engineer, give the best life when a steel gear is used on a cast-iron shaft.

Experiences with bearing loads for steel on steel and cast iron on cast iron were reported. For steel on steel, it was suggested that bearing loads should not exceed 90,000 psi. For cast iron on steel, or cast iron on cast iron, satisfactory operation can be expected at loads as high as 190,000 psi. Phosphate coatings on the cast iron on cast iron, or cast iron on steel applications, bring better results.

Tungsten carbide has been used by one company as a tappet face material and found to work quite well in most cases. The production control technique, however, was not satisfactory; and if incipient failure began, a rapid breakdown occurred with early failure of the part.

One diesel materials engineer reported comparative tests between camshafts made from carburized and hardened steel and induction hardened SAE 1040 steel. No difference was found in wear rate between the two materials heat-treated in the indicated manner.

Another engineer said that on large engines with heavy cam shaft loads, a steel camshaft and a chilled tappet met with best success. The chilled cam-type of cast cam shaft didn't operate as well as the hardened steel shaft against a chilled tappet. Phosphate or ferrox surface treatment was used on both the cam and tappets. Later the coating was successfully eliminated from the tappets. It was not possible to eliminate it from both parts.

Engineers were queried on causes of cam failures. Is it impact, scuff or fatigue, or perhaps something else?

One engineer reported that the cast-iron part almost always fails instead of the steel part. Since most engine builders prefer the tappet to fail instead of the camshaft—because of replacement cost—the tappets are often made of cast iron and the shaft of steel. This engineer believes steel fails principally by scuffing, while cast iron usually fails by fatigue.

Cast-iron tappet life can be increased by a low-temperature, stress-relief heat-treatment in the range of 800 to 1000 F. If the tappet is rotated so as to distribute the stress, fatigue failure can be greatly retarded.

It's extremely important that tappet and valve are aligned and that a spherical face on the tappet or taper on the cams match to prevent edge contact and concentration of stresses. Hydraulic tappet problems are the same as those of conventional tappets. If everything else fails to solve the problem, it becomes necessary to reduce the unit load between the tappet and camshaft. In one case, the design required a wider cam which was machined with 0 to 0.0004-in. taper to stop failures.

After experimenting with radius ground tappets and tapered cams on the camshaft, one company finally settled its production on flat tappets and straight camshafts to permit full contact between cam and tappet. The tappet guide was machined with sufficient clearance to permit the tappet to float somewhat, to maintain full contact with the cam face. The tappet was off-set somewhat from the cam to promote rotation and uniform wear of the tappet face.

A diesel engine engineer related his experience with flat versus roller type tappets. His company uses roller type cam followers, found necessary on the injector rods because of the high loads involved. This engineer believes that flat type followers could be used on valves since the loads involved are much lower than those for the injector rollers.

He reported that the surface finish on the pins and bushings on the inside of the rollers was extremely important. Any nick or upset metal would cause the roller to stick momentarily, and this would produce a scuffing between the roller and the cam. The result is excessive wear or failure. He emphasized the necessity of good finish on the bushing and the pin inside the roller.

Discussion turned to piston-ring groove wear and piston-ring side wear—especially in top piston grooves. The problem seems to be confined mainly to aluminum pistons.

One engineer reported considerable success using Ni-Resist type inserts for the top ring groove in an aluminum piston. An engine was fitted with tnree aluminum pistons without Ni-Resist inserts and three other pistons in the same engine were equipped with the Ni-Resist inserts. In a 9-hr test, during which 1¾ lb of air cleaner dirt was fed into the engine, 0.016 in. of side wear occurred on the plain aluminum piston, while the side wear was only 0.005 in. on the Ni-Resist inserted pistons.

A researcher said he found most wear on the ring and not on the groove. Wear occurs at the point where the ring becomes T-shaped, with the cross of the "T" being at the outer periphery of the ring where it does not contact the piston ring groove. This engineer feels that the ring wears, while the aluminum in most cases pounds out—especially after the clearance becomes excessive between ring and groove. This often results in ring breakage,

with the pieces pounding their way through the top of the piston land and into the top of the piston itself.

Micro-examination of aluminum in worn grooves shows numerous pits—some of which contain imbedded material. Some pits are empty because the material has been loosened and washed out by the oil. Analysis of the particles imbedded in the ring groove lands showed the material to be principally iron and various kinds of dirt.

Any material scuffed from the cylinder wall will combine with dirt coming in through the air system and serve as a lapping compound imbedded in the surface of the soft aluminum. Result is excessive ring wear. In one case, the ring was found to have worn 0.015 in. on the flat sides, while no wear was apparent on the groove. There was a lot of abrasive imbedded in the groove in this particular engine. Yet on other engines in the same fleet, using cast-iron pistons, side wear on the rings and high groove wear was not a problem.

Groove pounding is not a problem for two-cycle diesel operations, according to round-table discussions. In one particular engine, a cast-iron type piston is used and side groove wear does not cause field trouble.

Chromium plating the flat sides of the rings was suggested. A piston-ring engineer reported that this had been tried in certain engines. However, even with chromium plating as thin as 0.001 in., the microscopic roughness of the plate in the as-deposited condition was sufficient to abrade the aluminum rapidly on the sides of the piston ring groove.

Side wear of piston rings was said to parallel gem cutting using aluminum or copper discs, with diamond dust impregnated into their surface. This explains why dirt imbedded into the aluminum groove would rapidly abrade away the cast iron operating against it.

There were varying opinions on the effect of oil additives on ring side wear. Experiences were reported where additive oils seem to give greater side wear, and in other instances, additive oils caused no increase in side wear. One theory was expressed that since the additive oils prevent carbon from building up, the carbon carried in the oil may have more opportunity to become imbedded along with dirt into the sides of the ring grooves. Very little supporting data was available on either side of this argument.

Ring and Piston Failures

Two types of failure were described by one engineer, as illustrated in Fig. 1. Type "A" failure he described as "high temperature" type of failure, where the ring actually pounds the upper side of the groove and upsets the metal of the piston to a considerable degree. Type "B" failure is "low temperature" type of ring and groove failure. In this instance the ring is worn quite deeply on the flat side and assumes a "T" shape as a result of metal removal.

In most cases type "B" wear will be greater on the bottom side of the ring. In the "B" type of failure there may be no piston groove wear at all.

Annular grooves were observed by at least one engineer on the flat sides of the ring. This indicates that as the ring rotated against the abrasive imbedded in the flat sides of the piston ring groove, there was sufficient motion to produce the grooving effect in the flat face of the ring. It was also reported that some bus and truck operators have left out the top ring on pistons where three compression rings are used to get away from this top ring breakage and excessive ring groove wear.

One piston-ring manufacturer markets a steel spacer, so cupped that it can be inserted into the piston-ring groove on the top side of the ring. The spacer is made from high-carbon hardened steel and it is necessary to re-groove the piston before installing the spacer. Experience has shown the spacer to be effective in some installations, especially on the type "A" failure. On type "B" failures, in many instances the spacer was worn out in operation and did not save the ring.

Jacket temperatures were reported to be of some importance in the "B" type failure. One engineer told of instances where high cylinder wear accompanied the "B" type of failure, which he believed was caused by operating the cylinder at too low a temperature.

Ring design may have much to do with the flat side wear. A piston-ring engineer said that reducing ring width would lower the inertia loads and tend to stop the type "A" failure. Beveled or counter-bored rings which twist in the groove make the condition much worse. Rings with small radial thickness will increase the unit pressure against the piston ring groove and thus make the wear problem more acute. These twisted rings have higher unit pressure, since the inside upper corner is cut away. This reduces the contact area and increases the unit pressure between ring and piston ring groove.

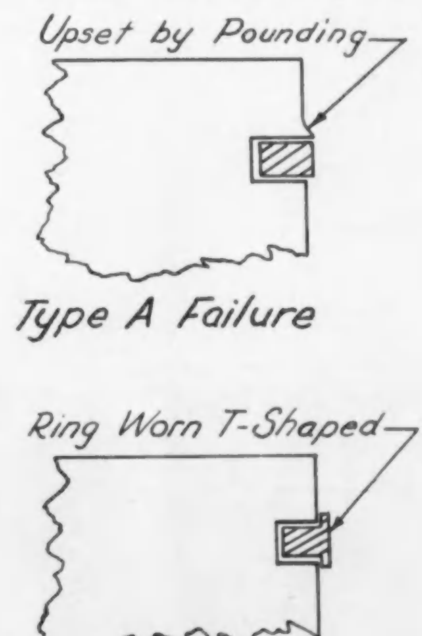


Fig. 1—Pounding of the piston ring upsets the upper side of the ring groove and causes the failure in Type "A." In the Type "B" failure, there is considerable wear on the flat sides of the ring which eventually takes on a "T" shape.

Is There an American Market

CONTINUED demand in the United States for imported models of four-passenger, shorter wheelbase cars as well as the entry of several American manufacturers in this field presage a sustained market for such cars. Two-car families, commuters, and salesmen find these less than 100-in. wheelbase cars practical because of their comfort, economy, satisfactory performance, safety, and advantage in traffic and parking.

The Market

A recent Cromwell-Collier survey indicates that 6.2% of all families have two cars. Assuming about 40,000,000 families in this country, this would mean about 2,500,000 families with two (or more) cars.

Many families that own Austins or other light cars have only one car; but if each of the two-car families had some sort of light car, that is a potential market alone of 2,500,000 light cars. Contrast this with Austin's most recent annual production of 126,365 units, which was a record high for the largest producer of cars and commercial vehicles in Britain.

Surely it would be optimistic to think that in every family with two cars, one of these cars would be a light car. But there's no reason why a great majority of those "second cars" shouldn't be well-made shorter wheelbase, four-passenger sedans.

Many groups of drivers can make excellent use of this type of automobile. There are many salesmen to whom gasoline mileage is an important factor. Suburban commuters everywhere can make good use of an inexpensive, yet good car. A man who drives to the suburban station has virtually no need for a six-passenger car. He wants dependable transportation and at near-minimum cost.

Then there is a large number of families who need and want a large car for touring and for various trips, but who find that near home, a smaller car is far more preferable. Families with growing children find urgent need for an extra car to get about in. Younger members of the family need and want their own individual means of transportation—but seldom want an over-sized car for their limited travel.

There also are many families consisting only of two people. For them, a six-passenger unit is more often than not completely unnecessary. They can travel in urban areas, or take long trips, having the entire rear seat and the luggage compartment for their personal belongings.

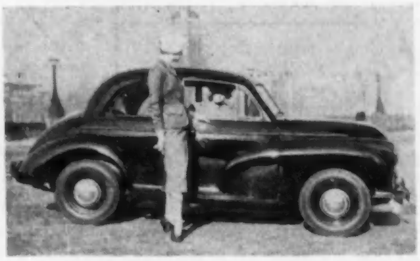
Extremely important is the great number of women drivers in this country. A smaller car is usually more suited to their needs. It steers easier, handles easier, parks more quickly and in less space, and generally takes less effort to drive. Older people, too, find it pleasurable to drive a car that is nimble, easily maneuvered, and yet thoroughly dependable.

More and more these people are finding, to their great pleasure, that a short wheelbase car is very sensibly built as to size and performance, and that some of the real fun of motoring has come back with these cars.

Shorter wheelbase and shorter overall length do not necessarily mean less comfort or less room for passengers. Taking the Austin, with which I'm most familiar and which outnumbers other foreign

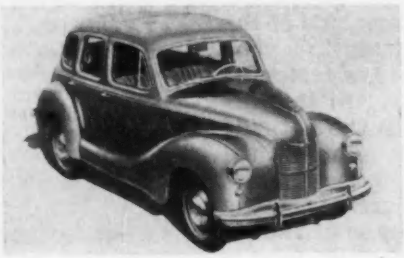
American & British 100-in.

Morris Minor Sedan



Weight .... **1583 lb**
Wheelbase .... **86 in.**

Austin A-40 Devon Sedan



Weight .... **2250 lb**
Wheelbase ...... **92½ in.**

Nash Rambler Convertible

Weight .... **2430 lb**
Wheelbase .... **100 in.**

for Shorter Wheelbase Cars?

EXCERPTS FROM PAPER* BY

John H. Wells, Sales Promotion Manager, The Austin Motor Co., Ltd. (England)

cars in this country, four six-footers can ride in this car in comfort. A smaller car in this instance does not mean less room. It means room, without excessive wasted room.

Most of the so-called "light cars" from Europe are powered with 4-cyl engines. Hardly any one will say the 4-cyl car is remiss in dependability. As you may know, only 12 cars finished in last year's Indianapolis 500-mile race and every one of these had four cylinders. And thousands of Jeeps which made a reputation during the war had 4-cyl engines.

Light cars are renowned for their gasoline mileage. Owners report, and tests prove, that the Austin can give as high as 36 mpg, and seldom less than 30. In the United States, there are many places where gasoline costs about 30¢ per gal. Thus, in an Austin, for example, the gasoline cost is more nearly 1¢ per mile instead of 2¢ for many American cars. In tests, an Austin averaged 30.4 miles per U.S. gal at a constant speed of 40 mph. At a speed of 30 mph, it averaged 33.3 mpg.

Oil capacity is usually less than the average American car; so is radiator capacity, which means a saving in antifreeze cost as well. And whether license plates are issued on a weight or on a horsepower basis, they cost far less for the Austin and other light cars than for the typical American car.

Add all these savings to the lower initial cost of the car itself, and you can see what we mean by economy.

Too many people look at the shorter wheelbase cars and are immediately worried, unnecessarily, about what they feel is inadequate weight. A car such as the Austin is virtually as heavy as the American smaller cars, measuring pounds to the length of car.

Many motorists are prone to judge comfort and riding qualities in a car by weight. You all know how many salesmen point with pride to the heavy weight of their models. There is no denying that this has been an effective sales point. But we feel that people are beginning to realize that good weight distribution, proper suspension and springing, and overall balance can give excellent riding qualities in a so-called "light car." Weight alone is not a guarantee of comfort.

Chief deterrent to broad acceptance of small, light cars is found in the feeling of fear people have when driving a diminuitive automobile on crowded highways. Salesmen of leading car makes continually point out, as a buying reason, the strong, shock-resistant structure of the present heavy car models. Thus the virtues of the narrow tread and short

* Paper "Will the Four-Passenger, Shorter Wheelbase Automobile Find a Better Place in the American Market?" was presented at SAE National Passenger Car, Body, and Production Meeting, Detroit, March 14, 1950. (This paper is available in full in multilithographed form from SAE Special Publications Department. Price 25¢ to members, 50¢ to nonmembers.)

(or less) Wheelbase Cars

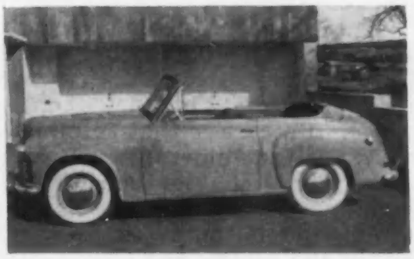
Kaiser-Frazer Henry J.

Weight .... **2350 lb**
Wheelbase .... **100 in.**

Ford Prefect

Weight .... **1817 lb**
Wheelbase .... **94 in.**

Hillman Minx Convertible



Weight .... **1995 lb**
Wheelbase .... **93 in.**

wheelbase are unconsciously denied the public. Yet with a normal, standard tread width and a wheelbase of about 100 in., the motorist can feel a new sense of safety because of the inherent balance of these proportions.

It's interesting to note that an Austin recently established an Algiers to Cape Town, Africa record. It operated about 10,000 miles over the roughest sort of terrain and broke the previous record by nearly four days. As for roadability, the Austin has a low center of gravity that is fully commensurate with its height, weight, and length. At a test in France, an A-40 Austin was driven at high speed around a track with the two outer wheels 1 ft higher than the other side of the car.

Let me say something about the performance of these shorter automobiles. Acceleration in these cars is adequate for all, except the real speed demons who measure their own driving ability by the speed with which they get away at a traffic light. Tests on the Austin A-40 showed that it would reach 50 mph in 20.5 sec from a standing start. The car can accelerate from 20 to 40 mph in 8.9 sec. For people who keep the smaller engine revving up, the short wheelbase car gives surprising performance.

It's difficult to show the average motorist that one car will go around curves better than another car. Nevertheless, Austin and other English car manufacturers are very proud of the way their cars "corner," or go around curves. In contrast, Englishmen complain about the lack of "cornering" ability in several American cars.

At present, the shorter wheelbase, four-passenger Austin sedan is enjoying wide popularity in Canada. For three winters, Canadians have discovered that Austin A-40's are excellent winter time vehicles. Their natural rubber tires seem to give superior traction in snow, and the low-low gear gives power to the rear wheels without so much tendency to "grab" or to spin the wheels.

American cities today are facing acute problems of traffic congestion. Narrow streets, inadequate parking areas, and more cars and trucks registered than ever before are only some of the contributing factors. In the middle of all this, the shorter wheelbase car shows up even better. Where long wheelbase vehicles, with tremendous overhang, are having their difficulties in maneuvering, these cars manage to get along with much less trouble and effort for everyone, particularly for the driver of these four-passenger cars.

In many places parking areas are marked for 17-ft cars. This means that when room for maneuvering is added, each car requires 20 ft of curb space. If the 17-ft car is provided for, and you drive an automobile similar to the Austin (whose overall length is less than 13 ft), it's easy to see how your individual parking problem is simplified.

Specifications of the Ford Model T, which put America on wheels, are probably a better guide to the scope of the small car market than the car design itself. The Model T had a 100-in. wheelbase and 60-in. tread, weighed 1400 lb, and was powered by a 22.5-hp engine. These specifications proved acceptable to the American public for a combination of reasons hard to beat.

They spelled adequate transportation, simplicity of engine, and practical fuel economy, which meant ease of maintenance, both mechanically and physically. Passenger comfort also met the public's requirement. Basically, with all the developments and features of design, equipment, and construction found in the industry today, it seems only logical to assume that—with perhaps some variation in horsepower—a car of these specifications would find a big market in America.

What's Retarding Supersonic Flight

Continued from Page 19

streamlined turrets have caused considerable airplane control and buffeting problems at speeds of only 400 mph.

At firing rates as high as 1,000 rounds per min, two rounds of ammunition per weapon are the most hits that can be made on a body 50 ft long if the target is traveling at 500 mph with respect to the weapons. See Fig. 8. When high speed aircraft are built of high-strength, thick-gage material, the lethal load required to dispose of an airplane will be much greater than any contemporary machine gun.

The armament problem seems to boil down to the following: The high-speed tactical airplane must have a power-operated device, capable of automatically dispatching a high lethal charge to several miles range, in a carrier that sniffs its way within a few inches of the vulnerable spot of a target. I forgot to mention that at no time during its operation must it extend itself beyond the normal lines of the airplane; and it must occupy a minimum of space within the airplane.

The last factor to go into our formula is escape from our high-speed aircraft. You have probably read and are familiar with our demonstration of seat ejection, where the pilot or other member of a crew can be thrown from an airplane. This system has proven to be an answer for speeds of 400 to 500 mph. At higher speeds we are uncertain that the human body can withstand the dynamics pressures or accelerations.

Our problem then is to have a capsule or portion of the airplane that can be separated from the airplane at all speeds, altitudes, and attitudes of flight. Like the one in Fig. 9, it will safely carry the crew members without any tumbling to an altitude and speed where the crew member can finish his trip to the ground in a conventional manner. As a finesse, we would like to have our capsule deliver its cargo all the way to the surface and be equipped with life raft, radio, stoves, rations, bunks, and so forth.

I don't believe that any of the problems facing us in our quest of transonic and supersonic speeds are insurmountable. But at the moment they do pose a challenge to engineers and scientists in aeronautics, as well as those in chemistry, mechanics, medicine, textiles, astronomy, and meterology.

BOEING'S

Model 502 Gas Turbine

EXCERPTS FROM PAPER* BY

H. M. Jacklin, Jr., Bureau of Ships, Department of the Navy

A Boeing Model 502 gas turbine powerplant has recently been installed in a Kenworth truck and run in road tests. (See photograph and personal note on page 81 of the May, 1950 SAE Journal.) Engineers foresee that gas turbines will permit more evenly distributed axle loading, added cargo-carrying space, and improved visibility for drivers of future trucks. But the immediate purpose of the present truck tests is to obtain test experience under varying operating conditions not easily obtainable otherwise.

The United States Navy is interested in the Model 502 for powering small boats because it can operate on aircraft turbine fuels—as well as numerous other liquid petroleum fuels and bottled gas. A Model 502 engine is now being service-tested in a plane-personnel boat. Other possible applications include buses, small airplanes, helicopters, generators, pumps, air compressors, mining equipment, and arctic vehicles.

THE Boeing Model 502 gas turbine engine—which has recently been installed in a Kenworth truck for test purposes—is characterized mainly by its light weight and small size.

As Figs. 1 and 2 show, the Model 502 consists of two main components, a gas-producer section and a power-output section. No mechanical connection, gear or shaft, exists between these sections. They are tied together only aerodynamically.

The gas-producer section of the latest design, which is basically the Model 500 jet engine, consists of a single-stage mixed-flow compressor and a single-stage axial-flow turbine mounted on a common shaft supported by two antifriction bearings and an intermediate sleeve-type steady bearing. All thrust is carried by the single-row ball bearing mounted next to the compressor, with the roller bearing mounted next to the turbine wheel and the steady bearing carrying radial loads only.

The compressor supplies air through two tangentially vaned diffuser outlet elbows to two can-type burners, where heat is added by burning fuel. The hot gas is then directed to the turbine wheel through a nozzle box. The energy removed from the gas in the turbine gives the power which drives the compressor and accessories.

The addition of the power-output section to the gas-producing section results in the Model 502 engine. The turbine wheel in the power-producing section turns at lower speeds than the turbine wheel in the gas-producing section and removes additional energy from the gas to give power to the output shaft through the double-step reduction gear. The exhaust gas from the power-output section is expelled to the atmosphere through diffusers and ducting.

The lubrication system is self-contained in the engine; however, an air cooler is required to dissipate the heat rejected to the lubricant. In this connection, studies and tests are now under way on using the engine fuel as the lubricant, which will eliminate the requirement for a cooler as well as provide an aid to more efficient combustion by preheating the fuel.

The engine speed is controlled by means of a governor operated by a single, adjustable, hand-throttle control lever.

An ignition system is required for starting only, after which combustion is self-sustaining. A fuel shut-off valve is employed for stopping the engine.

A comparison of the Model 502 engine and comparable power-output reciprocating internal-com-

* Paper "Potent Power Packages—The Boeing Gas Turbines" was presented at SAE Summer Meeting, French Lick, Ind., June 5, 1950. (This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

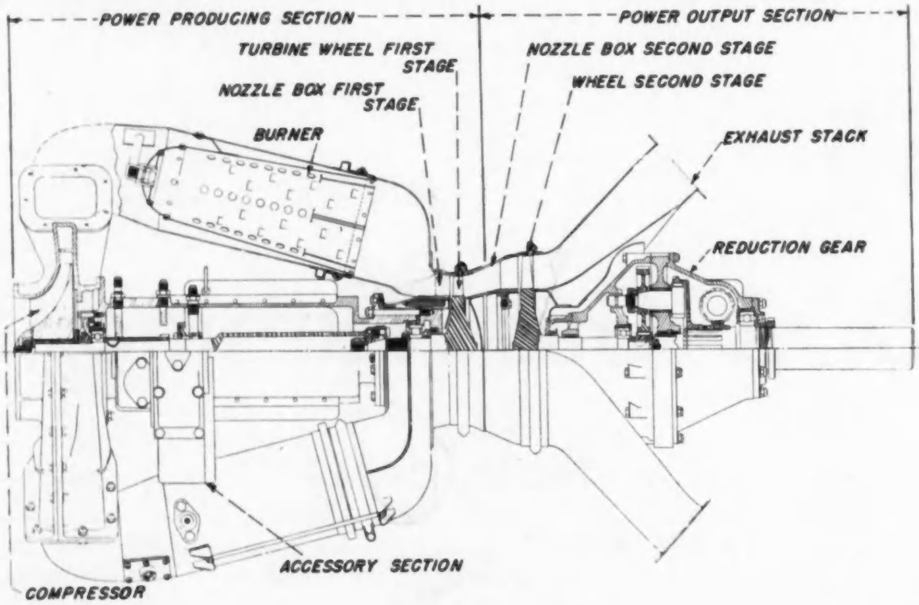


Fig. 1—Section drawing of Boeing Model 502 gas turbine engine

bustion engines gives the gas turbine a decided advantage in weight, space, and supply of parts, as is shown in Table 1.

In the Model 502 engine, a solid circulative lubricating system is employed, which is schematically illustrated by Fig. 3.

The lube-and-scavenge pump circulates oil at from 50 to 75 psi through a cooler, a filter, and a manifold—where it is distributed to the accessory drive, reduction gears, and shaft support bearings. The oil is returned to the sump from the accessory drive and shaft bearings by gravity and from the output-section reduction gear by the scavenge side of the pump.

The pump unit has two elements of the gear-type design, one for pressure and one for scavenging. A built-in, adjustable relief valve limits the oil pressure to the bearings. No external supply tank is required, since supply to the pump is obtained from the integral oil sump.

A single, replaceable-element filter is used for removing foreign particles from the lubricating system. It is connected between the cooler and the manifold on the pressure line. The replaceable element is of the paper type.

The lubrication manifold is used in distributing oil to the various bearing locations. Six separate lines are used, one to the reduction gear box in the

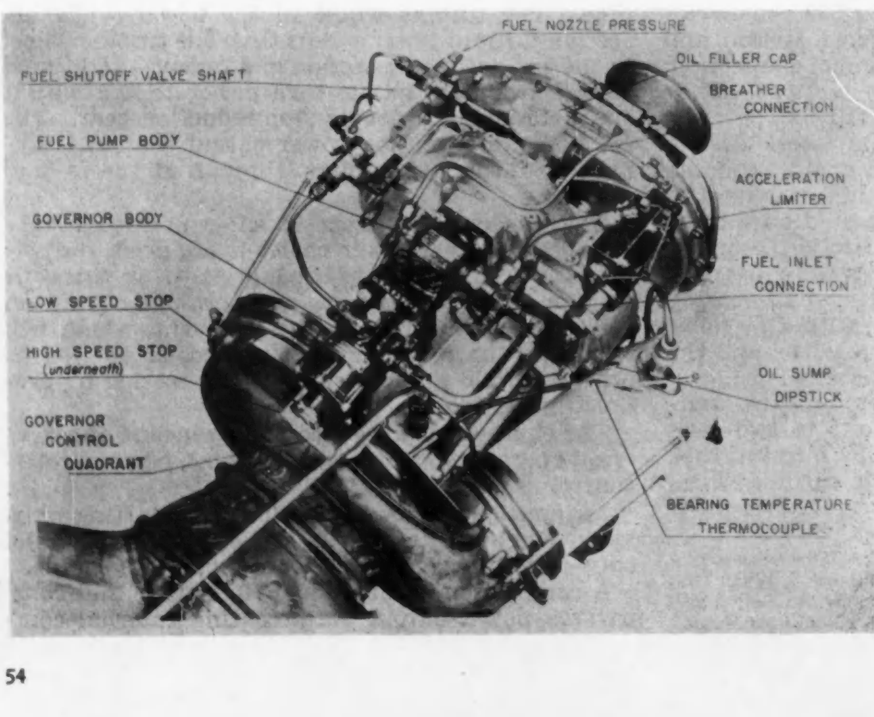


Fig. 2—Photograph of Boeing Model 502 gas turbine engine

power-output section where a single connection distributes oil to all bearings and in the gas-producing section, one to the turbine roller bearing, one to the steady bearing, one to the compressor ball bearing, one to the accessory-drive pinion on the main shaft, and one to the accessory drive bearings.

Fuel and Control System

The fuel and control system consists essentially of a governor, an acceleration limiter, fuel nozzles, and a manual shut-off valve as is schematically shown by Figs. 4 and 5. Fuel is supplied through a filter to the inlet side of the pump. From the pump outlet, two lines are provided. One leads to the governor, which controls flow to the nozzles located in the burners. The other line connects directly to the acceleration limiter, which prevents rapid fuel pressure rises, thereby limiting engine acceleration. The fuel pressure supplied by the pump increases in proportion to engine speed.

The governor is of the centrifugal type and is coupled to the fuel pump, thereby comprising an integral unit which is driven by the accessory-drive gear train. The governor is used to maintain the gas-producing section at a constant shaft speed for a fixed throttle setting.

The fuel nozzles are used to atomize the fuel and to discharge it into the combustion chamber inside of each burner where it mixes with compressed air and is burned. Each assembly consists of a screen and an insert. The fuel enters through the strainer and passes through grooves in the insert to the insert head, where it is discharged through the orifice in the nozzle tip.

The fuel filter has a small capacity for foreign particles, and will clog rapidly if the fuel is dirty. When it is expected that dirty fuel will be used, a larger filter should be placed in the inlet line ahead of this unit.

In order to insure reliable operation of the governor, the fuel must be free of all foreign particles.

The engine has been started using compressed air, powder cartridges, or electrical motor systems. Work is also going ahead on applying a small manual starter in connection with a magneto in order to eliminate the requirement for batteries, compressed air tanks, or special cartridges in service installations.

Reduction Gear

The purpose of the reduction gear in the power-output section is to reduce the high speed of rotation of the turbine wheel to a lower speed more suitable for shaft-drive applications. The reduction ratio is 9.06 to 1, which is obtained in two steps using a sun gear driving three planets, which in turn drive a ring gear that is splined to the output shaft.

Accessory Drive Gear

The purpose of the accessory drive is to transmit mechanical power from the main shaft of the gas-producing section to the accessories, driving them at reduced speed. Also, the starter, which mounts on the accessory box, transmits power through the gear train to the main shaft during the starting cycle.

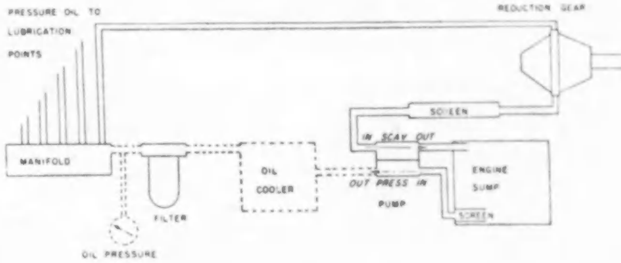


Fig. 3—Diagram of lubrication system of the Model 502

Four mounting pads are provided on the gearbox for accessories. These include the fuel pump and governor drive, the tachometer generator drive, the starter drive, and a spare drive.

The accessory gearbox is located above the main shaft housing and is fastened thereto with bolts. The various drives, for which there are four output mounting pads, are driven from a pinion on the main rotor through simple spur gears. One oil jet, located in the accessory gear case, furnishes oil directly to the vertical worm gear that drives the lube oil pump and the gear to the spare output pad. An oil jet located in the main housing supplies lubrication to the accessory-drive pinion and the driven gear. The remaining gears and bearings are lubricated by oil which is splashed throughout the case.

A breather is provided near the top front of the accessory case to maintain atmospheric pressure in the main engine housing and accessory gear case. Baffle-type construction prevents loss of oil through the breather.

Electrical System

The purpose of the electrical system is to start the engine. Once the engine is started, this system is no longer involved in sustaining operation or in stopping the engine. Various electrical arrangements are possible for any required application of the engine. Fig. 6 is an electrical-system wiring diagram for an installation using a 24-v d-c power source.

Starting Switch—The single-pole, single-throw,

Table 1—Comparison of Model 502 and Other Powerplants

	Model 502	Aviation Gasoline	High-Speed Diesel	Gasoline Industrial Automotive
[a]Part Numbers in Engine	175	310	480	396
[a]Number of Parts in Engine	220	825	1400	881
Number of Close-Tolerence Running Fits	16	100	135	100
Engine Weight, lb	200	395	2000	1500
Length, in.	38	38	70	55
Width, in.	22	32	30	26
Height, in.	22	30	45	46
Installation Envelope, cu ft	12.7	25.2	66	46

[a] Standard parts such as nuts and bolts not included.

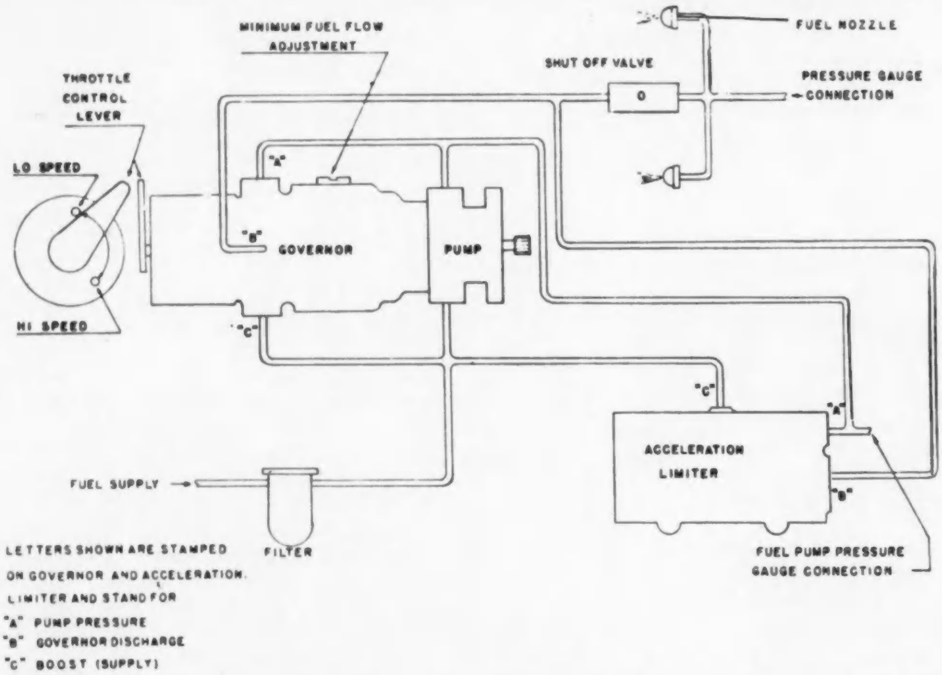


Fig. 4—Diagram of fuel system connections of the Model 502

momentary-contact switch which energizes the system when the push button is depressed is located on the control panel. During the starting cycle, the system is kept energized until the gas-producing section has reached a speed of 15,000 rpm. Release of the push button then cuts power to the starter motor and the ignition.

Starter Solenoid Contractor—The function of this unit is to complete the circuit to the starting motor when the switch is closed. The contactors connect the starting motor directly to the electrical supply.

Starter Motor—A 1.5 hp, 24-v d-c starting motor is used to start the gas-producing section. The motor is connected to the driveshaft through the accessory gear train, always remaining engaged. No slip or overrunning clutch is used.

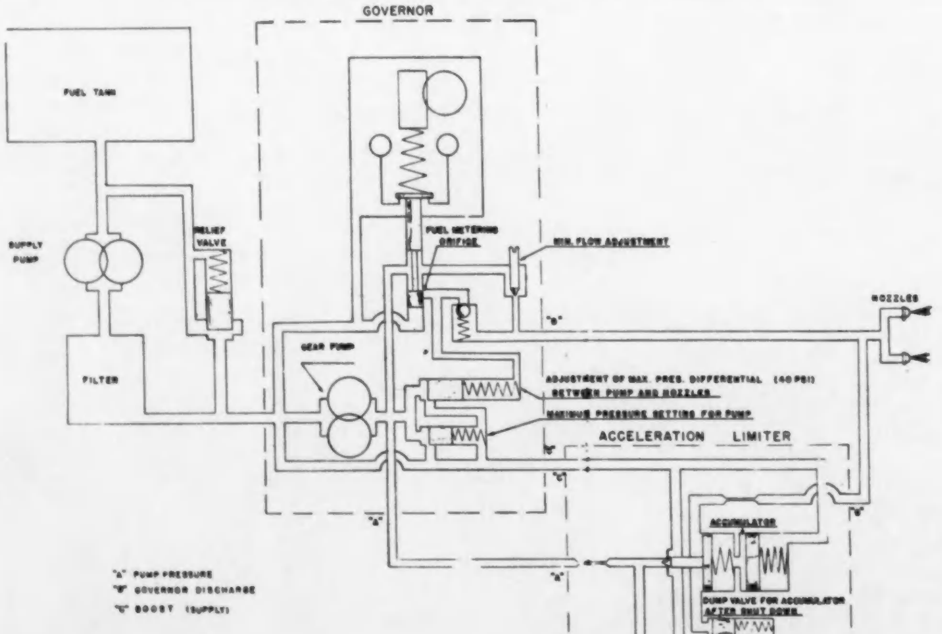


Fig. 5—Diagram of fuel system of the Model 502

The starter is mounted on the accessory gear case. Electrical connection is made by fastening the hot lead to the insulated terminal with the ground wire connected to the other terminal. The engine is grounded when the ground terminal is not included on the starter. Wire of 0 gage is generally used.

Spark Coils—The purpose of these units is to provide high voltage to the spark plugs as required for ignition during engine starting. Two coils are used, the high-tension output from each being led to separate spark plugs, the primaries being wired in parallel.

Spark Plugs—The purpose of these units is to facilitate the starting of combustion of the fuel by the utilization of a continuous high-voltage breakdown across an air gap. In operation, the high voltage is supplied to the plugs by the ignition coils for the duration of the starting cycle only.

24-v Battery or Power Supply—A 24-v, 34-amp per hr aircraft battery or four 6-v automobile batteries connected in series will give satisfactory service for starting requirements. Fresh batteries of these types will normally give six starts before requiring recharging. Consequently, it is desirable to provide a battery-charging generator on the spare output pad of the accessory gear case in applications where batteries are used for starting.

Performance

Fig. 7 illustrates the now accepted power, torque, and specific fuel consumption curves of the Model 502 engine at three different gas-producing-section shaft speeds.

The work since 1946 has been concentrated mainly on obtaining increased power and reliability with a secondary interest in obtaining increased efficiency. This approach has received severe criticism from various sources; however, for its requirements, the Bureau of Ships has considered that reliable horsepower in a small package, together with simplified logistics, overshadows the relatively poor efficiency now obtained as compared with reciprocating internal-combustion engines. Moreover, it was considered that to obtain efficiencies comparable to those of reciprocating engines would involve a long period of development which could be carried out after basic reliability had been established. The results to date have been exceedingly gratifying and have certainly substantiated the above approach, since reliability is now suitable for various service installations. Besides, power output has been more than doubled, reliability increased, and specific fuel consumption at peak powers has been improved from over 1.9 to 1.25 lb per bhp-hr with even greater relative improvements at part loads.

Work is, of course, going ahead to increase further the reliability, power output, and efficiency of the engine. It is expected that within 18 months, component improvements will bring the specific fuel consumption down to 1.0 lb per bhp-hr, the addition of regenerators will reduce that figure to below 0.70 lb per bhp-hr, the continuous-duty rating will be over 200 bhp, partload efficiencies will be considerably improved, and reliability will be at the point where about 2000 hr of life will be obtained between major overhauls.

Many of the problems associated with operating large gas turbines are not found in the Boeing engines. The wheel diameters in the gas-producing and power-output sections are 7 and 8.75 in. in diameter respectively, and the inertia of these wheels is not so significant as in larger turbines. In fact, they respond to speed changes so rapidly that gas flow requirements are thereby practically instantaneously matched, which avoids the danger of overheating the turbine blades when accelerating the engine's speed.

The "split" wheel arrangement also provides an infinitely variable transmission, thereby giving flex-

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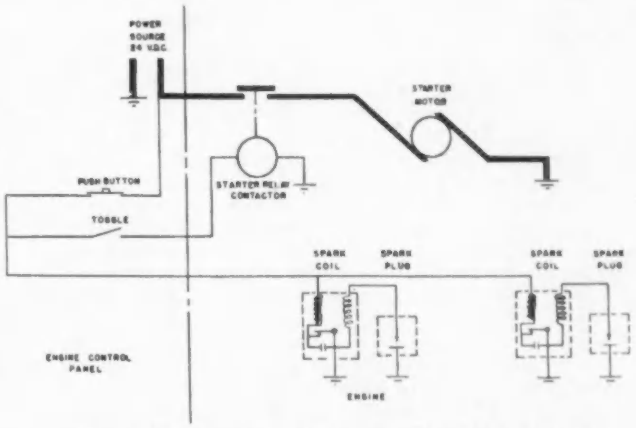


Fig. 6—Diagram of electrical system of the Model 502

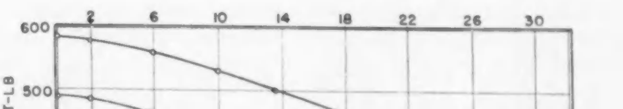


Fig. 7—Performance of the Model 502

The complete report, "Low Temperature Properties of Ferrous Materials," from which this article was taken, covers practically every aspect of the subject. Starting with a general discussion pointing up the low-temperature problem in various industrial applications, the report then goes into effects of low temperature on mechanical properties of iron and steel. An extensive section covers test procedures and equipment for measuring low-temperature embrittlement of these materials. The report also tells how metallurgical factors affect low-temperature behavior of ferrous materials, with a chapter devoted to effects of heat-treatment.

Adding to the practical value of the report are test and experimental data in the form of 22 tables and 56 figures and charts.

Copies of the report are available from the SAE Special Publications Department. Price: $2.00 to members, $4.00 to nonmembers.

Membership of the Low Temperature Properties of Ferrous Materials Division, of the SAE Iron & Steel Technical Committee, which authored the report, are: Dr. C. H. Lorig, Battelle Memorial Institute, chairman; D. L. Edlund, Vanadium Corp. of America; P. L. Goud, Detroit Arsenal; R. B. Hooper, Chrysler Corp.; A. Hurlich, Watertown Arsenal; J. W. Juppenlatz, Lebanon Steel Foundry; N. A. Matthews, Electro-Alloys Division, American Brake Shoe Co.; D. A. Shinn, Air Materiel Command, U. S. Air Force; L. E. Simon, Electro-Motive Division, GMC; R. N. Stenerson, Carrier Corp.; and Gosta Vennerholm, Ford Motor Co.

How Design Properties

THERE is no fundamental difference in the influence of the various design factors upon the behavior of steel parts at reduced temperatures as compared to room temperature. There is, however, a difference in magnitude of the effects of design upon the performance of steel structures at reduced temperatures which is directly traceable to the increased tendency of steel toward brittle behavior at low temperatures.

The necessity for avoiding sharp fillets in steel parts for use at normal operating temperatures because of the high stress concentrations associated with sharp re-entrant angles is well known and fully understood by design engineers. The dangerous influence of sharp fillets in ferritic steel parts intended for low-temperature service is even more pronounced than at room temperature because of the increased notch sensitivity at low temperatures.

Another factor associated with the increased brittleness at low temperatures is the increase in hardness which steel undergoes as the temperature is reduced. This increased hardness is reflected in an increase in the resistance to local deformation of the metal in the vicinity of the root of a notch, which in turn accentuates the stress-concentrating power of the notch. The decreased toughness of the metal as well as its increased hardness at low temperatures thus magnify the danger of sharp fillets in steel parts subjected to low-temperature service.

Design has an important influence upon the stresses arising in steel parts during heat-treatment and upon the residual stress pattern after heat-treatment. Since a large proportion of steel parts intended for low-temperature applications are heat-treated, many by liquid quenching, considerable attention must be devoted to design to minimize quench cracking and excessive distortion caused by sudden changes in section thickness, sharp corners, and so forth. This problem does not differ in any way from that of similarly heat-treated parts intended for normal operating conditions except that, under some conditions, low-temperature service accentuates the stresses remaining after heat-treatment.

Such increases in residual stresses at low temperatures are not necessarily always detrimental because those stresses may be in opposition to the stresses imposed by the service loading conditions.

The stresses set up in steel structures by welding may often impair the low-temperature performance characteristics because the presence of triaxial stress patterns enhances the tendency of steel to behave in a brittle manner. A more generally serious consequence of welding is, however, either the formation of microstructures, such as pearlite or coarse bainite, which are characteristically sensitive to low-temperature embrittlement or the formation of cracks in the soft and weaker constituents in the fusion or heat-affected zones.

Stress relieving after welding is usually desirable if possible; but since some alloy steels are susceptible to temper embrittlement as a consequence of heating in the range of temperatures usually employed for stress relieving, such practices must be employed with discretion, and only after ascertaining that the low-temperature impact resistance of steels intended for low-temperature applications is not too seriously impaired.

Large masses of steel are more prone to brittle fracture with little prior warning than thin sections, not only because it is more difficult to obtain the tough, tempered martensitic microstructure in heavy sections, but also because the increased constraint upon local deformation impaired by the surrounding mass of rigid metal promotes the brittle type of fracture. Because of the metallurgical difficulties, such as inability to obtain martensitic microstructures throughout the section, temper embrittlement, the increased tendency towards quench cracking which accompanies higher alloyed steels,

Affects Low-Temperature of Iron & Steels

This first-of-its-kind information for design engineers is part of a complete report on Low-Temperature Properties of Ferrous Materials, authored by the SAE Iron & Steel Technical Committee

and so forth, thick steel sections should be avoided whenever possible in structures intended for low-temperature applications where a high degree of toughness is mandatory.

It may often be preferable to specify high-strength thin sections rather than lower strength and heavier sections for parts to have good low-temperature toughness characteristics since the harder tempered martensite may have much better low-temperature impact resistance than the softer pearlite or bainite.

Surface Condition and Finish

Surface hardening treatments such as carburizing, nitriding, and shot peening produce fundamentally similar effects upon the affected regions of steel parts; the hardness is considerably increased, the ductility and toughness is decreased, and the surface of the part is placed in compression with residual stresses of greater or lesser magnitude depending upon the depth of case or, in the case of shot peening, depth and severity of cold work. The resultant hard surface layers are consequently very notch sensitive even at room temperature, and hence sharp fillets and re-entrant angles are to be avoided in surface-hardened steel parts for all normal temperature applications.

The influence of service at reduced temperatures is to accentuate the dangers which prevail at room temperature. Sound engineering design practice, such as employed in the design of surface-hardened parts for use at normal temperatures, is sufficient to guarantee satisfactory performance of such parts at reduced temperatures if care is exercised to specify steels and thermal treatments so that the core material will posses an adequate degree of toughness.

A difficulty which arises in carburized steel parts is that the base metal may have insufficient hardenability as a consequence of its low carbon content (0.20% or lower) and may transform during heat-treatment to microstructures containing large amounts of ferrite, pearlite, or high-temperature bainite. As a result, the core metal may have a pronounced tendency towards brittle behavior, and a crack, initiating at the surface, will propagate with little or no prior warning completely through the part with catastrophic suddenness.

Surface imperfections such as scratches, machine tool marks, stamped-in numbers, and other flaws may be focal points of failure of severely stressed parts at reduced temperatures. Again, the effects of surface condition are not greatly different from those observed at room temperature; but steels undergoing a reduction in toughness at reduced temperatures become more susceptible to failures

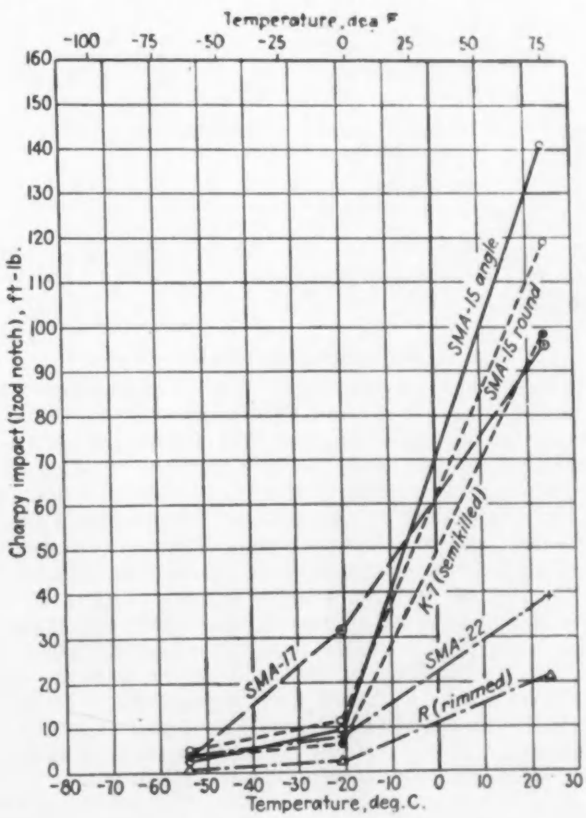


Fig. 1—Effect of deoxidation on low-temperature impact resistance of rolled low-carbon steels, whose composition is given in Table 1. Specimens for Heat SMA-15 were taken from 1-in. angles and 1-in. round bars. Specimens for other heats were from 1-in. round bars

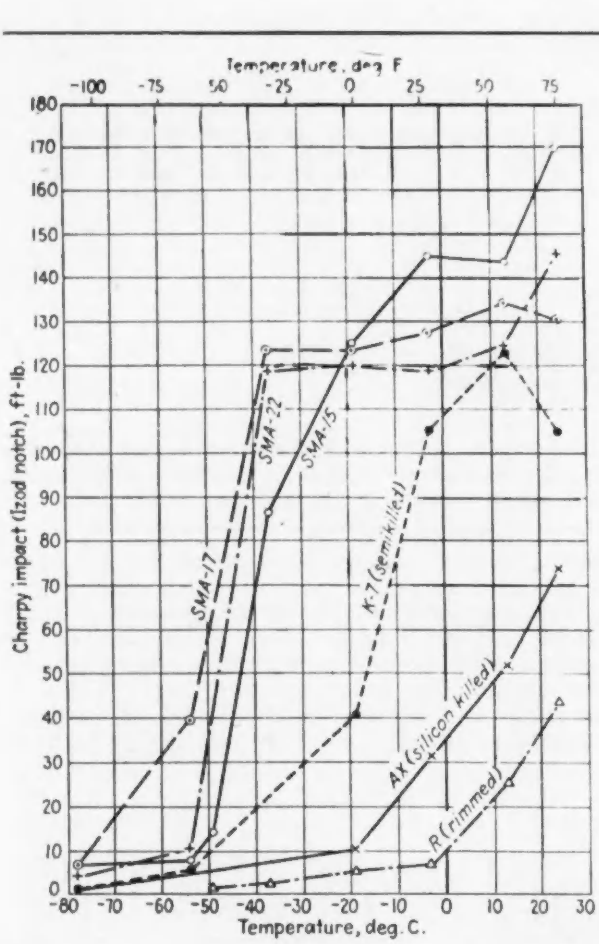


Fig. 2—Same as Fig. 1, except that steels were normalized at 875 C (1605 F)

arising from stress concentrations associated with surface defects.

Behavior Under Fatigue

The resistance of steel to fatigue increases at reduced temperatures consistent with the increase in yield and tensile strengths. An additional effect of low-temperature may be the marked acceleration of the rate of fracture once the fatigue crack has initiated because of the reduced toughness of ferritic steels at low temperatures. Thus, although reduced temperatures may enhance the resistance to initiation of fatigue cracks, they will greatly increase the rate of propagation of these cracks to final failure. In the design of steel parts subjected to fatigue loading at reduced temperatures, care must be taken to avoid high stress concentrations since the increased rigidity of the metal at low temperatures in the vicinity of stress raisers will have an increased tendency to lead to brittle fracture.

Selecting Steels for "Cold" Service

It is apparent that no set rule exists to govern the selection of a steel for a particular low-temperature application. The variables are so manifold that each part must be considered separately on the basis of the following factors:

1. Type and distribution of stress.
2. Rate of strain.
3. Specific temperature range involved.

In general, the more severe these conditions are, the lower must be the transition temperature of the steel in the Charpy test.

It is, therefore, apparent that where the maximum shear stress is high compared to the maximum principal stress, such as in torsion and the simple tension test under conditions of moderate rate of strain and temperate, steels with higher transition temperatures can be tolerated. Where high stress concentration and high rate of strain, as well as low service temperature are encountered, it will be necessary to select with low transition temperatures.

The ideal structure to obtain a minimum transition temperature in ferritic steel at a given hardness is tempered martensite, and any deviation from this ideal structure will result in higher transition. Hardenability is, therefore, an important factor.

In addition, the structural conditions, deoxidation, grain size, and susceptibility to temper brittleness must be considered.

Ordinary carbon steels in the as-rolled condition frequently show some susceptibility to notched-bar embrittlement in the range of temperature from room to -25 F. This is more often the case with rimmed and semikilled steels which are much more susceptible to low-temperature embrittlement than are the fully deoxidized carbon steels. The latter in the as-rolled condition usually retain their toughness at temperatures below -25 F. Low-temperature notched-bar properties of as-rolled or as-cast carbon steels tend to improve with heat-treatments which give grain refinement and structural uniformity.

The selection of steels for service in this temperature range is dependent upon so many variables concerned with the metallurgy of the steels and the conditions of service that no definite recommendations can be made.

For most applications it is probable that ordinary carbon steels will do, although in some instances the selection of fully killed instead of rimmed or semikilled steels would be justified. This would be especially true for extreme service conditions where high stress concentrations and high rates of strains are involved in applications at the lower end of the temperature range.

The acceptability of different grades of low-carbon steels, after various deoxidizing treatments, for low-temperature service is indicated from the work of Herty and McBride[1] which is summarized in Figs. 1, 2, 3, and 4.

The -25 to -100 F Range

Very few data exist relative to the selection of steels for service at temperatures in the range from -25 to -100 F. At temperatures below -100 F, the designer is prone to consider a change from ferritic

[1] See article by C. H. Herty, Jr. and D. L. McBride, "Effect of Deoxidation on the Impact Strength of Carbon Steels at Low Temperatures," Cooperative Bulletin 67, Min. and Met. Advisory Boards to Carnegie Institute of Technology and Bureau of Mines, Pittsburgh, 1934.

or martensitic steels to austenitic steels. At temperatures below -25 F, the designer is apt to change from plain-carbon steels to alloy steels. Within the range -25 to -100 F, most martensitic steels have either reached their transition temperature or begin to decrease in impact values, indicating that higher stress concentrations in structural parts than those present in notched bars might cause brittle failures.

Because of the grouping of such a large number of steels in this 75-deg temperature range, based on the results of the notched-bar values, there is quite naturally an overlap of transition zones and variation of transition zones throughout the entire range. This extreme overlapping and also wide scatter makes it impossible to separate steels into groups having comparable notched-bar results over 25 F temperature increments. Because of this fact, the separation of steels for use in structural parts within this temperature range is also impossible and probably will continue to be until much additional knowledge of the temperature effect is gained. A discussion of some of the methods and opinions relative to design for use in the -25 to -100 F temperature range is, therefore, all that is possible on the basis of present knowledge.

One method of eliminating questionable steels for use at low temperatures would be to discard those known to be subject to temper brittleness on tempering or on slow cooling. Such steels include the 1300, 3100, 3300, 5100, and 6100 SAE series. Some steels that are not appreciably subject to temper brittleness are the 2300, 4000, 4100, 4300, 8600, and 8700 SAE series, and would be safer selections if doubts relative to other steels existed.

In selecting a steel for service, the notched-bar test for the several steels under consideration may show individual transition zones over a fairly narrow range; but the range of the averages for the several steels may vary both above or below the service temperature. In such cases, the steels having their transition zones below the service temperature should be satisfactory for use, provided the stress pattern and rate of loading in the part are no more

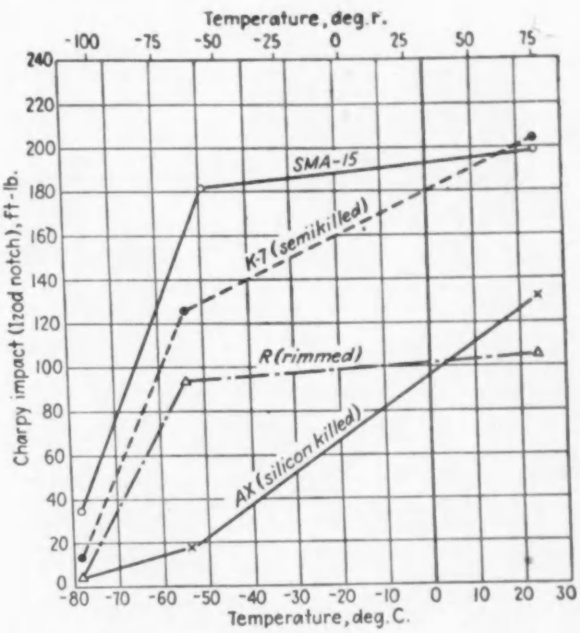


Fig. 3—Effect of deoxidation on the low-temperature impact resistance of low-carbon steels, water quenched from 875 C (1605 F) and tempered at 675 C (1250 F)

Table 1—Low-Temperature Notched-Bar Properties of Certain Normalized and Tempered Alloy Steels

Steel Number	Composition, per Cent	Condition of Steel***	Brinell Hardness	Type Notch	Charpy, Ft-Lb at °F 75	32	−50	−100	−150	−180
SAE 2315*	0.16 C, 0.62 Mn, 3.52 Ni	N. 1525° F.	186	K	52					26
SAE 4023*	0.20 C, 0.76 Mn, 0.23 Mo	N. 1600 F, T. 1000 F	156	K	62					16
SAE 8620*	0.23 C, 0.89 Mn, 0.53 Cr, 0.50 Ni, 0.27 Mo	N. 1600 F, T. 1000 F	217	K	57			22		7
SAE 9420*	0.23 C, 0.90 Mn, 0.50 Si, 0.33 Cr, 0.31 Ni, 0.11 Mo	N. 1600 F, T. 1000 F	170	K	54					27
SAE 9440*	0.45 C, 1.25 Mn, 0.33 Cr, 0.24 Ni, 0.13 Mo	N.1525 F, T. 1000 F	269	K	25			15		14
SAE 9540*	0.43 C, 1.38 Mn, 0.59 Si, 0.57 Cr, 0.52 Ni, 0.23 Mo	N. 1525 F, T. 1000 F	321	K	22					16
—*	0.15 C, 0.50 Mn, 2.0 Ni	Normalized	128	K	61			32		7
—*	0.10 C, 0.50 Mn, 3.5 Ni	Normalized	133	K	58					40
—*	0.10 C, 0.50 Mn, 5 Ni	Normalized	147	K	55					42
Cast steel**	0.18 C, 0.50 Mn, 5.50 Cr, 0.50 Mo	Normalized and tempered	207	K	22	16	13	5	4	
				V	24	18	14	6	5	
Cast steel**	0.10 C, 13.0 Cr	Oil quenched 1800 F, T. 1200° F.	228	V	26	22	17	5	4	
		N. 1800 F, T. 1300 F	217	V	37			5		
		N. 1800 F, T. 1200 F	225	V	26			5		
		N. 1800 F, T. 1100 F	240	V	19			5		
		N. 1800 F, T. 1000 F	275	V	15			4		
		N. 1800 F, T. 900° F	350	V	7			3		

* Information taken from Tables IX and X, pp. 208 and 210, respectively, Metals Handbook, 1948 Edition, ASM.
** Unpublished information from Lebanon Steel Foundry, Lebanon, Pennsylvania.
*** N—Normalized
T—Tempered

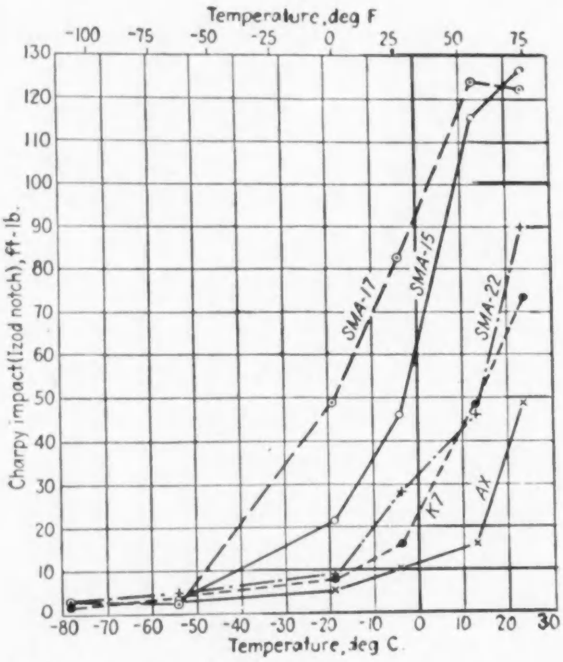


Fig. 4—Same as Fig. 1, except that the steels were heated to 100 C (2010 F) and air cooled

severe than for the impact test used as the basis of selection. If the part has a much less severe stress pattern and slower rate of loading, any of the steels might be satisfactory.

Therefore, it should be remembered that the most that can be said of various steels having different transition temperatures is that the steel with the lowest transition temperature is the one least *likely* to fail in a brittle manner in service.

Some steels, instead of showing marked transitions from ductile to brittle failures, over a small temperature range, in the conventional impact tests, exhibit a gradual decrease having a more or less linear relation to temperature. The selection of such steels for service is sometimes based on the results of a keyhole-notched Charpy test at the lowest temperature likely to be encountered by the part.

An arbitrary value can be assigned as the minimum that the impact specimen energy-absorption value should exceed before the material should be considered for use. This value would naturally depend on the nature of the part, but a value of 15 ft-lb (keyhole notch Charpy) has been used to considerable advantage in the selection of materials for such applications as earth moving and mining equipment. This figure is also specified in ASTM Specification A-300 as the minimum value acceptable for materials for use in low-temperature pressure vessels.

Limitations of Arbitrary Value

It should be emphasized that this 15-ft-lb figure has no magic power and will not be applicable in many instances of highly concentrated, triaxial, or rapidly applied loads, which may also be present at room temperature, but the effects of which may be magnified at low temperatures.

It will be noted that impact values have been the only basis of selection mentioned in the preceeding discussion of design of parts for low-temperature service. It is possible that other tests may be developed in the future or new interpretations of present tests may become available, which will be a more satisfactory method than the use of impact values. At the present time, general mechanical tests (excepting tear tests and other various special notch sensitivity tests) usually predict increased hardness, tensile and compressive values, other static property values, and fatigue life.

Data relative to effect of static tensile values in the presence of notches indicate decreasing strength with decreasing temperature in some instances, but the data are relatively meager. Notched fatigue data are still fewer and consideration may be necessary in some instances as to the possibility of fatigue strengths at low temperatures being lower than at room temperature.

In view of this discussion and remembering that the following is only a very broad generality, it can be stated that plain low- and medium-carbon steels may be usable to -50 F or even lower in some cases, and low-alloy, low-carbon steels, and the standard SAE alloy steels are usable to temperatures of -100 F and below. These remarks apply only to steels made

Table 2—Low-Temperature Notched-Bar Properties of Certain Chromium-Nickel Austentic-Type Steels

Type of Steel and Composition		Condition ***	Type Specimen	Notched-Bar Impact Values: Ft-Lb	Temp., °F	Ft-Lb	Temp., °F
302 Wrought*	0.11 C, 16.2 Cr, 11.5 Ni	W.Q. 2010 F.	V-notch Izod	118	-85	118	-292
302 Wrought*	0.09 C, 18.51 Cr, 9.65 Ni	A. 1900 F.	V-notch Izod	113	-110	119	-300
304 Wrought	0.07 C, 17.14 Cr, 8.24 Ni	A., CD.	V-notch Izod	68	-110	65	-300
316 Wrought*	0.07 C, 18.41 Cr, 9.88 Ni, 2.80 Mo	A., CD.	V-notch Izod	77	-105	80	-300
302 Cast**	0.07 C, 19.0 Cr, 9.5 Ni	A.	Keyhole Charpy	75	-75	64	-150
				57	-320	52	-423

* Information taken from Table XVI, page 210, Metals Handbook, 1948 Edition, ASM.
** Unpublished information from Lebanon Steel Foundry, Lebanon, Pennsylvania.
*** W.Q.—Water quenched
A.—Annealed
CD.—Cold drawn

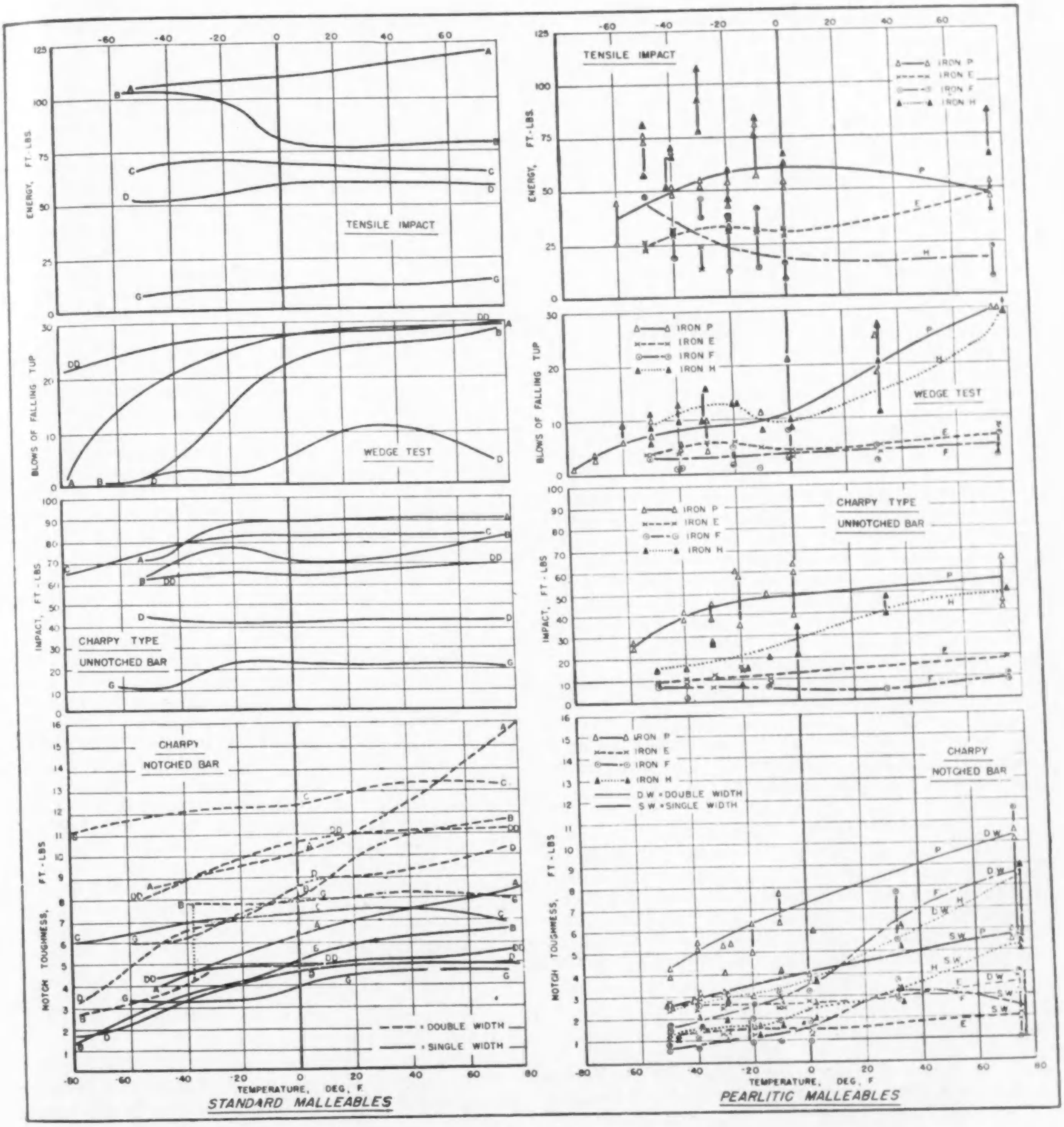


Fig. 5—Low-temperature properties of some commercial standard, short-cycle, cupola, and pearlitic malleable irons

under the best practice as outlined under other sections of this report.

The selection of steels for service in the range -100 to -200 F follows the line of reasoning explained above. However, at these lower temperatures the choice of steels becomes more limited where the service is such that impact properties are considered of importance. Certain ferritic steels retain an appreciable degree of impact resistance over this temperature range; but detailed consideration must be given to melting and deoxidation practices, heat treatment, and subsequent thermal treatments such as welding and stress relieving. If low-carbon alloy steels—such as those containing nickel, nickel-molybdenum, or chromium-molybdenum—are to be used, it is preferable that liquid quenching be adopted to achieve a tempered martensitic structure unimpaired by tempering maladies discussed above. Values are given in Table 1 which indicate that certain normalized and tempered steels are

satisfactory under proper conditions of processing.

Most of the common austenitic stainless steels are satisfactory over this temperature range, as the values given in Table 2 suggest. Proper quench-annealing treatment is important; but this practice is common in the industry. These steels are less likely to be adversely affected by melting and deoxidation practices or subsequent welding or other thermal treatments.

Steels for -200 F and Under

At these lowest temperatures, only normalized and tempered, and quenched and tempered low-carbon alloy steels of the nickel, nickel-molybdenum, chromium-molybdenum, and manganese-molybdenum varieties are recommended besides the austenitic stainless alloys. If ferritic steels are employed for highly stressed parts, the most careful attention to detail is required in their processing. Stress-relieving treatments must be applied with caution and only those welding techniques and materials which have been carefully proven should be utilized.

Present experience indicates that the austenitic stainless steels will be generally employed for service at temperatures below -200 F. Their impact properties remain excellent if the nickel and chromium and minor elements are adjusted to yield a completely or substantially austenitic low-carbon alloy. If these precautions are taken, there appears to be little variation in properties from heat to heat if proper quench annealing is applied.

At these very low temperatures, great care must be taken in the application of welding and other types of post heat treatments. The type of electrode coating becomes important if impact properties comparable to the base metal are to be retained in the weld deposit and interface zone.

Selecting Other Ferrous Materials

Gray and white cast irons, because of their inherently low ductility and toughness, are seldom tested either for tensile ductility or notch-bar toughness. Unnotched specimens are sometimes broken in impact; but there is scant information on the effect of low temperatures on impact properties. In low-temperature service these materials appear to perform as satisfactorily as they do at normal temperatures.

Malleable iron castings are being used successfully in a variety of low-temperature applications. As a rule they show ductile behavior at fairly low temperatures.

Tensile-impact, wedge-test, unnotched Charpy and keyhole Charpy (for specimens of both single and double width) properties over a temperature range from +80 F to -80 F were reported by Simmons, Rosenthal, and Lorig[2] on some commercial standard, short cycle, cupola and pearlitic malleable irons. The types of malleable irons tested are listed in Table 3, and the results of tests are summarized in Fig. 5.

For wedge testing, a cast specimen 6 in. long and 1 in. wide, tapering from ¼ to 1/16-in. thickness over its length and held upright at its widest end. was subjected to the impact of a 21-lb tup which dropped between guides through a distance of 3-1/3 ft, to impart an energy of 70 ft-lb per blow. Results are recorded as the number of blows, under 30, to cause fracture.

The notched Charpy values and the wedge test values of all the irons tended to decrease with reduction in temperature, the loss in properties being, for the most part, gradual with decreasing temperature. The standard type of malleable iron did not appear to be particularly sensitive to low temperatures in the tensile impact tests, but the pearlitic malleables behaved more erratically. The unnotched Charpy bar values dropped slowly with temperature, the loss, however, being slight with all irons except for the cupola malleable.

The study revealed that there are definite differences in toughness between different lots of standard malleable iron, and that the pearlitic malleables are somewhat inferior to standard malleable in low-temperature impact properties. Some of the differences between standard irons, noted by their notched and unnotched toughness values at the different temperatures, could be traced to the microstructure; but not in all cases were microscopical examinations capable of accounting for these differences. In the unnotched condition, both standard and pearlitic malleables are capable of resisting a considerable amount of impact, and appear to be relatively insensitive to effects of temperature down to -80 F.

Nickel-Base Alloys

The nickel-base alloys of the Monel and Inconel types, as well as others, have excellent ductility and toughness at low temperatures. All the alloys increase in strength at low temperatures without a serious loss in ductility. These alloys are structurally stable and are insensitive to embrittlement over the entire range of low temperatures investigated. It can be assumed that welds of the alloys will be tough at temperatures down to -300 F and even lower.

Table 3—Types and Compositions of Malleable Iron Tested Approximate Compositions Reported by Producer, Per Cent

Designation	Type	Composition, %				
		T.C.	Si	Mn	S	P
A	Standard	2.30	1.05	0.30	0.084	0.162
B	Standard	2.33	0.98	0.34	0.078	0.168
C	Short cycle	2.32	1.31	0.41	0.092	0.071
D	Short cycle	2.38	1.46	0.35	0.072	0.097
G	Cupola	3.25	0.65	0.57	0.156	0.10
P*	Pearlitic	2.33	0.98	0.34	0.078	0.168
E	Pearlitic	2.27	1.22	0.48	0.17	0.11
F	Pearlitic	2.23	0.96	0.81	0.09	0.15
H	Pearlitic	2.23	1.14	0.64	0.08	0.11

* Same as iron B, but heat-treated to be a pearlitic malleable.

[2] See article by O. W. Simmons, P. C. Rosenthal, and C. H. Lorig, "Study of Malleable Castings, Properties for Military Applications," The Foundry, Vol. 71, 1943, October, pp. 102-104, 109; November, pp. 122-125, 190-192; December, pp. 106-108, 202-204.

Car Heater CRITERIA

EXCERPTS FROM PAPER* BY

F. A. Ryder, Chief Engineer, South Wind Division, Stewart-Warner Corp.

DESIGNING passenger car heating systems—whether hot water or combustion heater types, such as those shown in Figs. 1, 2, 3, and 4—is a dual job. First, the system must satisfy passenger comfort criteria. Second, the equipment should fit within the restriction physical confines of the vehicles without sacrificing passenger comfort.

The heater engineer must cope with 11 main design criteria, which apply to bus as well as car heating systems. They cover:

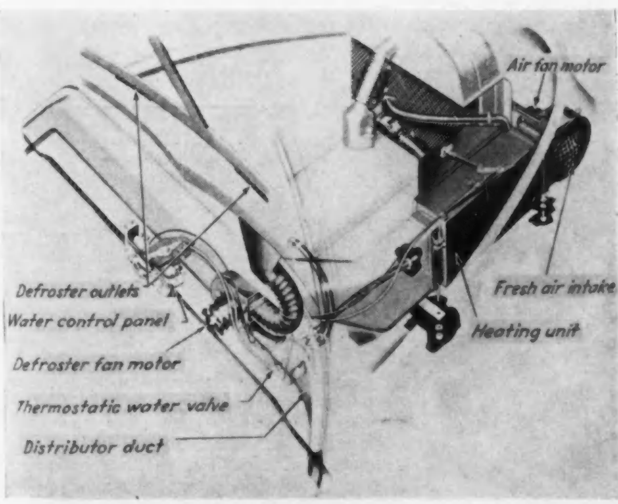
1. Oxygen needs.
2. Heat requirements.
3. Odor.
4. Humidity.
5. Dust.
6. Temperature.
7. Ventilation.
8. Heat load.
9. Defrosting.
10. Noise.
11. Power.

The oxygen required for the average adult under ordinary conditions is about 0.0012 cfm and the carbon dioxide generated by the individual is about 0.001 cfm under similar conditions. Under quiescent conditions, the air breathed by the individual is approximately 0.42 cfm and the ventilation necessary to provide minimum oxygen is 1.67 cfm at sea level; at the altitude of the highest mountain highways, the ventilation rate should be approximately 2.5 cfm.

The average adult under quiescent conditions must dispose of approximately 400 Btu per hr by means of convection, radiation, evaporation, and expiration of breath. The temperature of the skin should be approximately 86 F; of the head, 88 F; of the hands, 85 F; of the trunk, 87 F; and of the feet, 80 F.

To lose heat at the optimum rate and under comfort conditions requires an optimum distribution of body heat loss. This distribution is effected by air currents or so-called drafts. In general, drafts around portions of the body where the allocation of

* Paper "Modern Developments in Vehicle Heating," was presented at SAE Chicago Section, Nov. 8, 1949. (This paper is available in full in mimeographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)



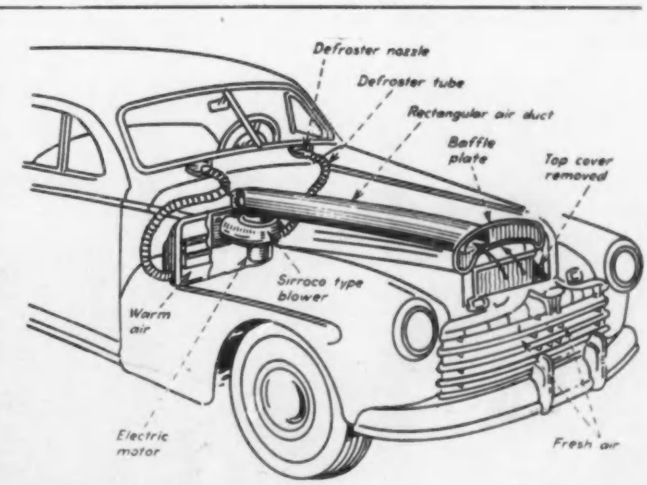


Fig. 1—At left is the Chrysler fresh air heating system—a hot-water type. Installation of the Ford fresh air heating system is at right. The Ford main duct is attached to the hood with rubber mounts. The motor-driven blower is mounted on the engine side of the firewall. The hot-water heater is mounted on the firewall inside the driver's compartment. The ram effect introduces fresh air into the passenger compartment in warm weather. The driver can close valve in the duct to stop circulation. Driver controls also include a three-way switch for controlling blower speed, hot-water circulation valve controls, valve for controlling admission of air to driver's compartment or defroster

heat loss is small will result in local discomfort.

As a general rule, if there is sufficient oxygen and if the concentration of carbon dioxide is sufficiently low for comfort conditions, a satisfactory odor level will be obtained. It is common practice in the aircraft industry to provide approximately 20 to 30 cfm of air. High quality railroad accommodations provide approximately the same amount as in aircraft.

In bus design about 35 cfm is required and approximately 60% of this amount is recirculated. For optimum conditions in an automobile, where there is less than 50 cu ft of space per occupant, approximately 20 cfm of fresh air should be provided to yield a satisfactorily low odor level.

A wide range of relative humidity may be tolerated. Extremely high or low relative humidities are uncomfortable and, if carried to the extreme for long periods, can be harmful to health. A relative humidity above 70% will result in an unpleasant amount of skin surface moisture; values below 25% will cause dryness and itching of the skin. Unpleasant symptoms in the eyes, nose, and throat also are encountered.

From the medical point of view, recent research has indicated that the relative humidity is an important factor in the control of bacteria. For example, many kinds of bacteria which cause frequent human ailments cannot exist in atmospheres slightly above 50% relative humidity.

Obviously, it is desirable to eliminate the induction of contaminated air into the vehicle. In addition to the cleanliness problem dust and other foreign particles may carry bacteria and create a hazard. Furthermore, during certain seasons of the year, plant pollens are particularly irritating sources of discomfort. There is very little information available to establish satisfactory thresholds of dust concentration. In the case of pollen, however, it is well known that a concentration less than approximately 10 grains per cu yd will not be noticeable. In several parts of the country concentrations as high as 750 grains per cu yd have been obtained.

It is commonly assumed in the domestic heating field that a temperature on the order of 68 to 70 F, and relative humidities of approximately 40% yield the most comfortable conditions. These criteria, of course, are based on tests of a relatively large number of individuals and the established criteria represent average or nominal comfort conditions.

But different individuals require different conditions to be comfortable. For example, it is commonly known that women, who ordinarily wear light clothing, usually require a higher ambient temperature than men, who ordinarily wear heavier clothing. This difference between the reaction of the two sexes to ambient conditions is not due only to the difference in clothing. There appears to be a definite physiological explanation for this difference, although its precise nature is not known.

There are very few criteria which the designer may use in selecting the desired ambient temperature of the vehicle. But for passenger cars, a temperature on the order of 60 F ordinarily is quite satisfactory.

If the ventilation rate were selected only on the basis of the required quantity of oxygen, it would not be necessary to provide for the induction of any fresh air into the vehicle. There is almost always sufficient infiltration around doors and windows and other joints in the vehicle structure to provide sufficient oxygen. If the ventilation rate were to be established on the basis of the need for obtaining a satisfactory odor level, there would also be no forced induction of air needed, unless there is a very large number of individuals in the vehicle. If a passenger car is carrying no more than the number of individuals for which it is designed, there will usually be no particular problem in obtaining a low odor level.

Until relatively recently a passenger heating system was of the recirculating type in which the air to be heated was circulated through a heat exchanger of various designs. There was no forced induction of fresh outside air into the car or heater. More recently there has been a marked trend toward the induction of fresh air. Several factors must be taken into account in determining the optimum rate of air induction.

One of the most important factors is windshields and windows fogging. The average individual dissipates a considerable quantity of moisture. Fogging can be prevented only when the concentration

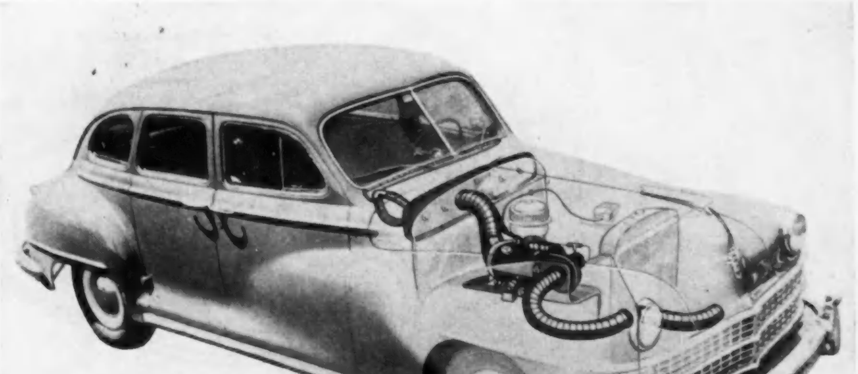


Fig. 2—This is a Stewart-Warner fresh-air type combustion heating system mounted in a sedan. Fresh air is drawn into the heater through a duct terminating in front of the radiator and forced into the heat exchanger by a blower. The heated air is ducted through the firewall and to a long, narrow plenum chamber. There are connections for conducting warm air to the defrosting nozzles. The system is completely automatic and delivers about 20,000 Btu if needed

of water vapor in the air is sufficiently low to prevent condensation on the glass. This means simply that the dew point of the air must be lower than the temperature of the inside surface of the glass. In the average car under average conditions, approximately 140 cfm of air are required to prevent fogging. Since this quantity of air will also provide very excellent ventilation, the induction rate can be based on the rate required to prevent fogging. It is not always possible to achieve this induction rate because, under many conditions, the heat load will be excessive.

The required heat output of the heater depends upon numerous factors, such as:

a. Thermal transmittance of the walls of the vehicle,
b. Size of the vehicle,
c. Ambient temperature,
d. Desired temperature within the vehicle,
e. Fresh air ventilation rate which is desired, or needed because of other factors,
f. Infiltration and exfiltration by the doors and windows of the vehicle, and
g. Speed of the vehicle.

Obviously with so many factors affecting the required output of the heater, it is not possible to establish rigid criteria. It is, however, necessary to consider carefully these factors to be certain that sufficient heat will be available under most driving conditions.

Since heat required depends so much on the ventilation rate desired and since the minimum ventilation required for odor circulation varies with the number of occupants, many systems are designed so that the relative amounts of fresh air and recirculated air can be varied over a very wide range.

There is another factor which makes it desirable to permit 100% modulation of the fresh air rate. In heavy traffic it is possible to induct excessive quantities of obnoxious fumes from the exhausts of other vehicles. It is desirable under these conditions to permit manual closing of the ventilating air duct by the driver.

It was stated that approximately 140 cfm of air are required to prevent fogging of transparencies. But ventilating air rate of 140 cfm will introduce an excessive heat load under many conditions. Under extremely adverse conditions, it is much more desirable to provide for only local defogging or defrosting, rather than to prevent defogging of all the transparencies. This results in a much more economical design. If the design is satisfactory from the technical point of view, it will provide very rapid defrosting of the windshield transparency. Well-known methods are used.

The method most used provides for ducting a relatively small quantity of heated air to discharge nozzles located directly under the windshield. This type of design rapidly defogs and defrosts the windshield, but usually has very little effect on the other transparencies such as windows. Another method is to use a small fan for circulating interior air across the windshield or other transparency. This usually is not very effective unless the air in the vehicle is comparatively warm. Of course the dew point of the air must be below the inside temperature of the transparency.

Defogging the windshield is a relatively simple problem; but rapid defrosting of the exterior surface of the windshield is far more difficult. In the latter case a heavy ice coating may accumulate on the outside surface if the vehicle is left exposed to extremely rigorous climatic conditions. When an attempt is made then to operate the vehicle, the windshield wipers are of no value and in many cases cannot be operated without damaging them.

There are very little data available in the technical literature regarding the criteria for good defrosting design. It can be shown, however, that in

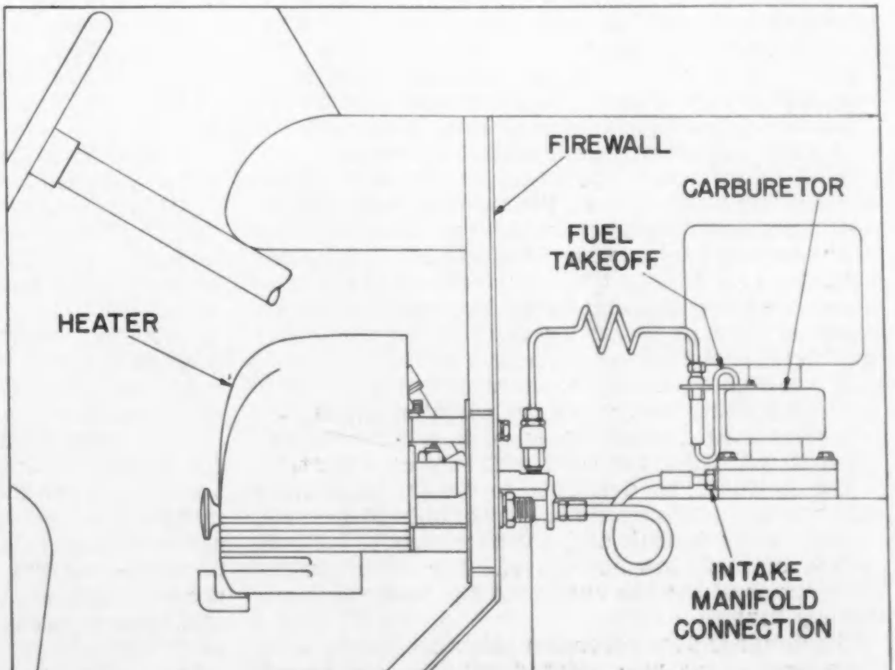


Fig. 3—Shown here are the major functional elements of the Stewart-Warner Model 909 combustion heater. The heater exhaust is connected to the vehicle intake manifold. Fuel is drawn from a jet in the vehicle carburetor or, in later models, from a separate float bowl. Intake manifold vacuum draws air and fuel through the entire system. A heated wire ignites the fuel and exhaust products are discharged into the manifold. Cross-sectional view of the heater is shown in Fig. 4

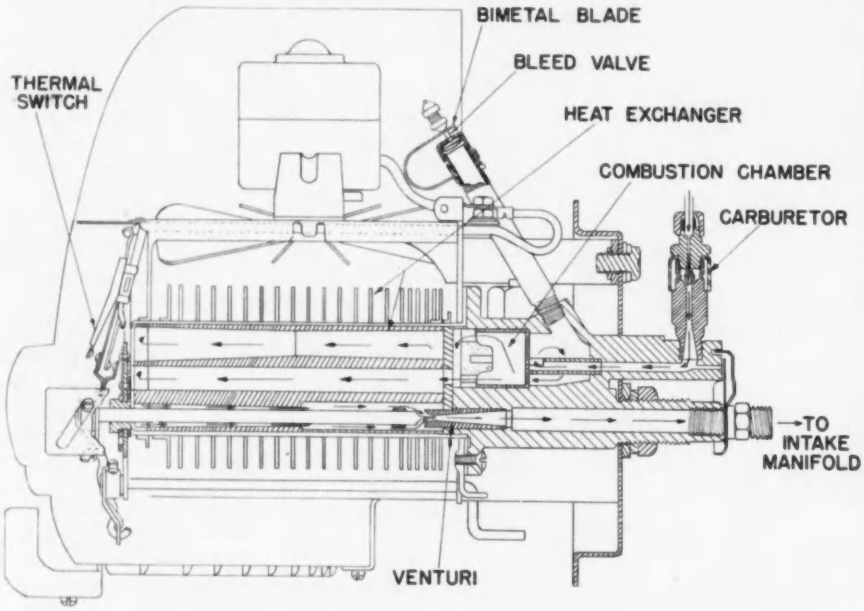


Fig. 4—Cross-section of the Stewart-Warner Model 909 heater. The fuel, mixed with a small amount of air, is drawn into the carburetor, where additional air is added. This mixture passes into the combustion chamber and is ignited by a heated wire coil. After several passes through the heat exchanger, exhaust products pass through a flow-limiting venturi tube, then through the exhaust line to the engine intake manifold.

The heat exchanger is a multiple-pass type. On the ventilating air side it has copper fins pressed on to a copper tube. A thermo-sensitive switch at the end of the heat exchanger extinguishes the igniter and turns on the fan.

If the device should overheat, a bimetallic U-shaped blade opens a small valve which vents the burner to atmosphere and extinguishes the flame. In case of ignition failure, the fuel-air mixture is discharged into the engine. Adding to safety of the device is the fact that the combustion side of the system operates at less than atmospheric pressure

a passenger car the discharge of approximately 13 cfm at the lower edge of the windshield, through a slot-type nozzle, at a temperature of approximately 175 F or above, will yield very excellent results under almost any conditions. The air temperature must not be extremely high and the nozzle must be designed for fairly uniform distribution. Otherwise, the transparencies may fracture because of sudden introduction of local strains.

It is desirable to minimize the noise level produced by the heating equipment. The noise sources are the motors for driving fans, turbulence due to high air velocities in ducts and walls, and burner noises in the case of combustion type heaters.

In the ordinary quiet home, a noise level of 30 to 35 decibels is quite common. In an automobile a very much higher noise level can be expected. The noise level, of course, will vary with the speed of the car, the condition of the engine, and whether the windows are open. A noise level as high as 70 decibels is encountered under many conditions.

When a noise level of this magnitude exists in the vehicle, the noise level of the heating equipment is not important because it will be very low compared to the ambient noise level. This point is particularly important because of the nature of acoustical phenomena which exist in nature. For example, an increase of 100% in energy level (producing the noise) will increase the noise level only 3 decibels.

It has been stated in the literature that the noise level of heating and ventilating equipment should not exceed 40 decibels because, if it exceeds this level, it will interfere with ordinary conversation. While it would be desirable to design equipment which would produce a noise level of only 40 decibels, it is certainly difficult and not necessary to achieve such a relatively low noise level. The noise level in the interior of the car under most conditions is extremely high.

The designer does encounter other difficulties with noise level if, as also pointed out, the equipment produces noises of unusual spectral distribution. Also while the noise level in the vehicle is high under most driving conditions and extremely high under high-speed conditions, it may be relatively low (on the order of 40 decibels) when the engine is idling, all windows are closed, and there is no appreciable traffic noise.

Under high-speed conditions, the vehicle operator may not be aware of the noise produced by even fairly noisy heaters (or other devices). But if he suddenly reduces speed and enters a very quiet area, the noise level of the surroundings will be reduced greatly. The noise of the noisy equipment then will be very noticeable and a source of considerable irritation.

As a practical matter, to establish a reasonable and yet satisfactory criterion for noise, it is contended that a noise level on the order of 50 decibels produced by the heater or its associated apparatus is satisfactory.

The electrical power required by the fans or other devices of the heating equipment is an extremely important factor, and one which has not been given sufficient attention by designers. The actual power required by such devices is in the absolute sense very small. A large, 100% fresh air, hot-water type heater may be operated by a motor requiring a power input on the order of only 60 w. In many cases this power input is much less. In the case of extremely small, completely recirculating type heaters, the power input may be only 20 w.

But in the modern vehicle, the power available for heating equipment usually is quite limited. In a passenger car the head lamps will require approximately 90 w and the radio 35 w, a total of 125 w. In a 6-v system, this will mean that the current will be approximately 21 amp. In most passenger cars the generator capacity is only slightly above 30 amp, and some power is required for the ignition system, head lamp relays, and so forth.

It is certainly obvious that the heating equipment

should not require more than 10 amp and preferably much less. The car radio, of course, is not operated continuously. And during the day time, head lamps are not used. Under such conditions the power required by the heater is not particularly important. But the system must be designed so that there will be sufficient generator capacity to take care of the more rigorous conditions.

The designer should consider the equipment from the standpoint of good practices in the field of fluid mechanics. He should strive to reduce the pressure drop of the equipment and of the ducts to reduce the power requirements and to reduce the noise level. The power required is a function of:

a. Mass rate of flow,
b. Pressure drop of the system, and
c. Efficiency (of the motor and fan).

For a given system (fixed parameters), the power required varies as the cube of the mass rate of flow. Therefore, it often is desirable to design for a relatively low air rate in the interests of conserving power or, to sacrifice somewhat on the air rate in the interest of achieving a very large saving of electrical power.

After satisfying these design criteria, the designer is faced with finding a suitable location for his heater equipment. And that's not easy in modern cars.

Until fairly recently, it was universal practice to mount the heater in the passenger compartment. The heater was fastened to the firewall and the required piping and other connections were made through holes in the firewall. The trend now is to avoid this type of mounting, particularly in the very latest cars, because in many cases it is extremely difficult to find a suitable place on the firewall. The trend is toward use of instrument panels which extend out from the firewall only a very short distance and blend into the firewall and toeboard. With this type of design it is extremely difficult to achieve an attractive, unobtrusive installation.

In many modern cars, particularly 1949 and 1950 models, provision has been made for built-in duct systems. This makes it almost mandatory to install the heater in some portion of this system. The duct connection from the heating and ventilating system to the firewall occupy a great portion of the space on the engine side of the firewall which would be available otherwise for the dash-mounted heater.

If car designers are convinced that the cowl ventilating system is a superior system, this presents some extremely difficult problems. The cowl ventilator introduces air directly into the passenger space. Therefore, it would seem reasonable to install the heater in this space rather than the engine compartment. If the heater is to be installed in the engine compartment and the cowl ventilator is to be used, than the duct system will become extremely complicated.

Yet there is no particular reason why the advantages of the cowl ventilator could not be retained and still mount the heater in the engine compartment. The position of the firewall, instrument panel, and cowl ventilator can be modified so that the cowl ventilator introduces air directly into the engine compartment and through the heater by a sealed duct.

Many ways have been used to achieve satisfactory temperature distribution and air circulation within the vehicle. This problem is particularly acute with sedan-type passenger cars. It is necessary to introduce the heated air at points in close proximity to the passengers and still avoid excessively cold or hot drafts.

In the older systems, the air was introduced at some point near the firewall. In most cases this was also the position of the heater. Forced induction of fresh air was not used. With this type of system it is extremely difficult to provide any reasonable comfort at the rear seat.

Attempts were made to correct this situation by designing heaters which could be mounted under the front seat of the car and to discharge the heated air to both passenger compartments. This system can produce excellent conditions for the entire vehicle. But it is an expensive installation, particularly for hot-water-type heaters, because of the long coolant pipes necessary from engine to heater. There were also service difficulties because a heater mounted in this position is not readily accessible.

Another very serious disadvantage is the difficulty of designing a satisfactory defrosting system for the windshield. In some cases this problem was partially solved by a separate defrosting blower; and in some cases a small heat exchanger was added to this defrosting-blower system.

While the under-the-seat mounting has disadvantages, it certainly has advantages worthy of attention. This is particularly true at the present time because of the difficulties of mounting a heater on the firewall of a modern car, or even in the engine compartment. The under-the-seat mounting position may be available to the car designer for many years to come because it does not appear to be useful for much else.

It is extremely difficult to provide satisfactory comfort conditions in a passenger car because the warm air must be delivered in close proximity to the passengers. This is particularly true with fresh air systems in which a considerable quantity of air is introduced. If this air is discharged into the passenger compartment at the firewall by a duct and small grille, there is quite likely to be excessive velocity and, therefore, an uncomfortable condition.

For this reason, many recent systems have rather elaborate distribution plenum chambers and discharge nozzles provided. The heated air is discharged into the plenum chamber. Such a chamber may be a flat duct mounted on the firewall, with discharge slots at the bottom and with provisions at the top for conducting heated air through the defrosting system. With this type arrangement, it usually is possible to achieve quite satisfactory conditions.

Although the use of a large quantity of fresh air introduces additional problems, this practice tends to provide more comfortable conditions in the rear seat of sedan-type vehicles. The induction of a large quantity of air tends to provide greater turbulence within the automobile and more satisfactory mixing. Since air will be lost by the vehicle by exfiltration around doors and windows, this will tend to provide more satisfactory temperature gradients.

(This paper also discusses requirements for heating systems of commercial and military vehicles.)

18,000-Ton
Housed in

THIS country's largest hydraulic forging press is installed together with all the other equipment needed to produce large pressure forging in a new plant at Grafton, Massachusetts, operated by the Wyman-Gordon Co.

The huge press, shown in Fig. 1, is capable of exerting a force of 18,000 tons. Its bed area is 6 × 12 ft. The press alone weighs 5,000,000 lb. The complete installation including pumps, piping, motors, and other equipment totals 9,000,000 lb. Table 1 gives other specifications.

All tie rods, cylinders, and other highly stressed parts are made of forged heat-treated alloy steel. Specifications for the press allowed a maximum deflection of the bed of only 0.014 in. with full pressure applied to an air area 40 in. square. With full load applied to the total bed area, maximum deflection allowed was 0.012 in. The press was designed to take a maximum working load of 18,000 tons when applied 12 in. off center, 9000 tons 24 in. off center, or 6000 tons 36 in. off center.

The press' hydraulic system (Fig. 2) utilizes a hydropneumatic accumulator. Three centrifugal pumps driven by high-speed motors deliver water to an air-water bottle. The pressure of air stored in the air bottle maintains a head on the water. The water compresses the air until the pressure in the system equals the shutoff pressure of the pump. Then the impellers do not move any water, although

* Discussion "Required Production Facilities for Large Pressure Forgings" was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 7, 1949, as part of Producibility Panel on "Significant Structural Design and Fabrication Developments." (Complete panel is available in multilithographed form from SAE Special Publications Department. Price: 75¢ to members, $1.50 to nonmembers.)

In his complete discussion, Mr. Motherwell explains that all three forging methods—impact, mechanical, and hydraulic—consist of exerting pressure on metal but that they differ in the rate of application of pressure and the temperature of the blank and dies.

Ferrous metals respond well to the sudden blows and high temperatures of impact and mechanical forging equipment.

The light metals magnesium and aluminum respond better to the squeezing action of hydraulic forging presses. Since these metals can be forged at temperatures around 800 F, dies can be kept near the forging temperature and the slow action does not cause excessive heat loss from the work piece.

Large magnesium and aluminum forgings are of current interest for aircraft. Designers of airframes for high-speed flight are resorting more and more to large light-metal forgings to secure high fatigue strength, save weight, and reduce assembly costs.

Mr. Motherwell's discussion was part of a three-discussion panel on "Significant Structural Design and Fabrication Developments" for aircraft. Digests of the discussions by Pipitone and Wolfe appeared in the July Journal.

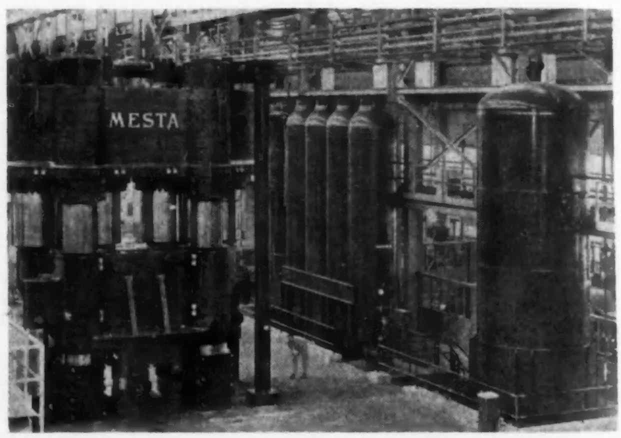


Fig. 1—18,000-ton-capacity press with prefill tanks and accumulator bottles

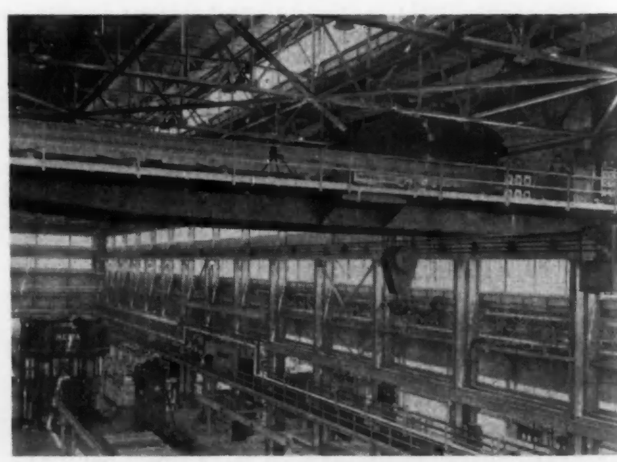


Fig. 3—100-ton crane having capacity of 200 tons in middle section, 20 ft from each crane rail

Hydraulic Forging Press Massachusetts Plant

BASED ON DISCUSSION* BY

George W. Motherwell Works Manager, Wyman-Gordon Company

they continue to rotate and absorb power, which is wasted in heat.

The air bottle serves as a shock absorber in the line. It has no moving parts or packings. Pressure can be varied by adjusting the air pressure, which air compressors maintain.

The press was installed with the help of the crane shown in Fig. 3. Wyman-Gordon found that the

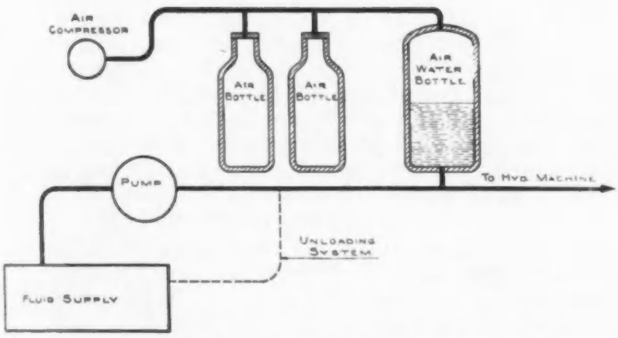


Fig. 2—Hydraulic circuit

Table 1—Specifications for 18,000-Ton-Capacity Hydraulic Forging Press

Weight of largest casting, lb	348,000
Total power (including three 1000-hp pumps), hp	3355
Maximum water pressure, psi	5300
Volume of water in system, gal	19,000
Height of press above floor, ft	32
Depth of press below floor, ft	15.5
Volume of concrete in press area, cu yd	2150
Column length, ft	46
Column diameter (four columns), ft	3
Piston diameter (four pistons), ft	4
Push-back diameter (two push-backs), ft	2
Platen size, ft	12.3×7.1
Stroke, ft	5
Pressing stroke, ft	1.5
Pressing speed, in. per min	150

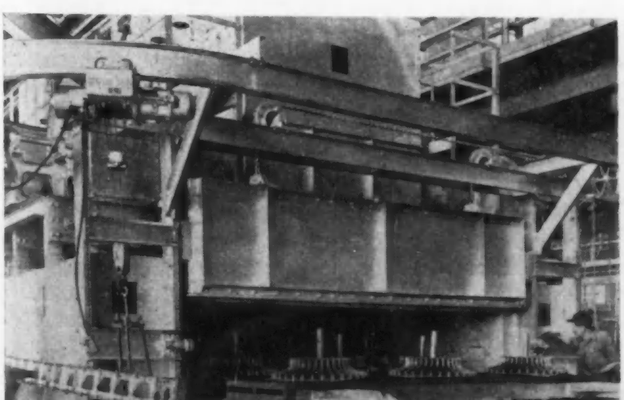


Fig. 4—Charging end of heat-treating furnace

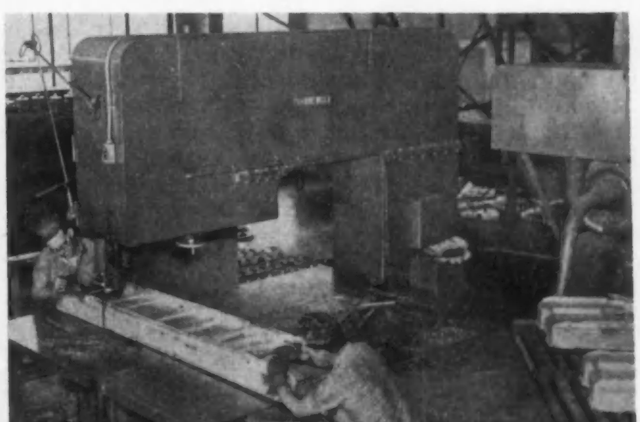


Fig. 5—Band saw with 7-ft throat

Fig. 6—Trim press with 74 × 139 in. bolster, 36 in. shut height, and 18 in. stroke

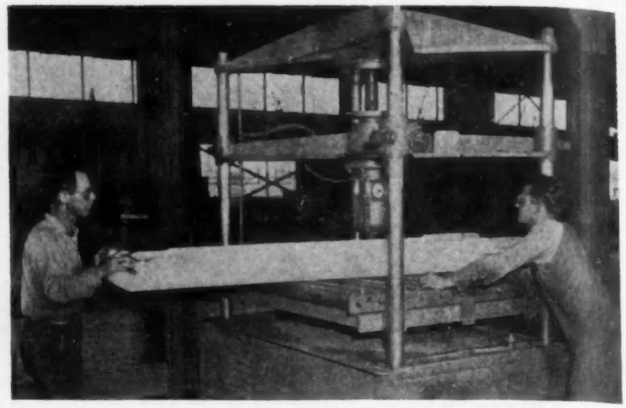


Fig. 7—Special brinell machine for large parts

extra cost of erecting a building capable of supporting the crane was about balanced by the reduced cost of press installation. Now the crane is proving invaluable in handling dies and making press repairs.

To insure sufficient furnace capacity and operating flexibility to keep the press in use as much of the time as possible, Wyman-Gordon installed three apron conveyor furnaces having a total capacity of 12,000 lb per hr. Another furnace of 4000 lb per hr capacity is also available. The furnaces are of the radiant-tube, propane-fired type, with fully automatic temperature control to within ± 10 F over the entire range from 200 to 1000 F.

Fig. 4 shows the charging end of one of the conveyor furnaces. The roller rail hearth is 12 × 60 ft. Split baskets 6 × 3 ft proceed two abreast.

Parts discharged from the furnace are automatically quenched. No more than 15 sec elapses from the opening of the furnace door to immersion of the parts. The water can be held at any temperature from 70 F to boiling.

Automatic safety devices protect against the hazards of failures of the gas, air, electrical, and temperature controls.

Both a large band saw and a trim press are used at the Grafton plant to trim forgings. The band saw, shown in Fig. 5, is used for large forgings ordered in small quantities. When quantities are large enough to warrant the expense, trim dies are made and used in the 1000-ton trim press shown in Fig. 6. This type of press is useful also for auxiliary operations such as bending and sizing.

Finished forgings are inspected carefully. The taking of brinnell hardness readings, one of the inspection procedures performed, is facilitated by the special equipment shown in Fig. 7. Large parts can be rolled through on a conveyor.

Boeing's Model 502 Gas Turbine

Continued from Page 57

ibility in the Model 502 similar to that of a steam turbine. The characteristics of this transmission are similar to a hydraulic-type torque converter in that the output shaft can be stalled with the gas-producing section producing full power. The output torque at this condition is twice the normal full-speed torque.

In order to obtain good fuel consumption under all conditions of varying loads, it will be desirable in most applications to add a number of gear changes. However, the gear changes can be fewer and of greater simplicity than ever before used because of the infinitely variable transmission feature. The net result may be an engine and transmission of practically the same space requirement and weight as previously used transmissions.

As would be expected, power and efficiency increase as the ambient temperature decreases, thereby making the engine attractive for use in cold climates. Further, the low friction losses in the engine result in power requirements which remain practically constant during starts even in subzero weather. Indications are that full power can be obtained within 1 min after starting at temperatures as low as − 70 F.

Because of the high air-fuel ratio used, the exhaust gases of the engine have no offensive odors and no carbon monoxide is generated. Therefore, the engines may be used in areas where gasoline reciprocating engines are normally dangerous to personnel.

The engine has been operated on high octane gasoline, kerosene, 50 cetane diesel fuel, bunker C oil, and bottled gas. In order to obtain optimum performance with any given fuel, only minor adjustments are required. However, in emergencies, almost any available fuel may be used, at least for short periods, without adjustment.

Automotive Fiberboard Finished Three Ways

Based on paper by

J. W. GREIG

Woodall Industries, Inc.

FIBERBOARD is made by separating fibers from vegetable matter, assembling them into a web, and pressing them into a sheet of structural material. The processes are similar to paper making, except that the final sheet is thicker.

Most fiberboard is made from scrap paper. But the fibers start out as wood, cotton, flax, or jute. They are separated from the fibrous material by cooking with sulfate, sulfite, or soda solutions or, sometimes in the case of wood, by grinding.

A water suspension of separated fibers from scrap paper or direct sources flows onto a moving wire screen belt. The sideways vibratory motion of the belt tends to interlace or felt the fibers.

This much of the process is common to all fiberboard. There are three ways of completing the product.

Method 1—The thin wet web passes over drying rolls, emerging as a sheet of paper. Sheets are coated with an adhesive glue and bonded together to form a board of the desired thickness.

Container board, chip board, and other low-cost boards are made this way. The material sews well, can be scored and bent, but is not water resistant if the adhesive is water soluble. Boards made by this process are used for seat back trim foundation, upper-quarter trim foundation, and break-over strips.

Laminated board is sometimes embossed and lacquered to make a more decorative, water-resistant board and used for cowl kick panels, dash panels, visors, trunk lines, head lining for trucks, and rear package trays.

High-strength water resistant boards are made by saturating sheets of kraft paper with asphalt to waterproof the fibers, then bonding the sheets with rubber latex.

Method 2—The web on the moving screen—a web much thicker than that used in Method 1—is cut to length, then compacted at elevated temperatures to predetermined thickness. Resins in the wood pulp bind and waterproof the fibers, insuring reasonable dimensional stability.

The result is stiff panels of high strength and toughness. They are used for lining delivery trucks, house trailers, and station wagons.

Method 3—The wet web formed from pulp to which asphalt and resin have been added is deposited on a revolving cylinder. The web winds layer over layer until the desired thickness is achieved. Then the sheet formed on the cylinder is slit and removed to pans to dry. The length of the board is the same as the circumference of the cylinder.

Because of the asphalt and resin, the material will not delaminate in water. The asphalt imparts thermoplastic characteristics, which allow the board to be formed under heat. But the asphalt interferes with painting.

This type of board is used for arm rests, dash liners, plenum chambers, and air ducts. (Paper "Fiberboard Products Used in Automotive Production" was presented at SAE Annual Meeting, Detroit, Jan. 13, 1950. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Ram Jets, Rockets Retarded By Inherent Characteristics

Based on paper by J. H. WALKER Applied Physics Laboratory, Johns Hopkins University

RAM jets and rockets offer promise for supersonic speeds because each develops tremendous thrust. But each poses tough engineering problems. The ram jet has to move fast before it develops thrust. The rocket is a terrific fuel consumer.

The ram jet's attraction lies in its fuel consumption on a pounds fuel per hour per thrust horsepower basis. Its fuel consumption is less than that of all other known types over a large portion of the supersonic region. In fact it compares favorably with the piston

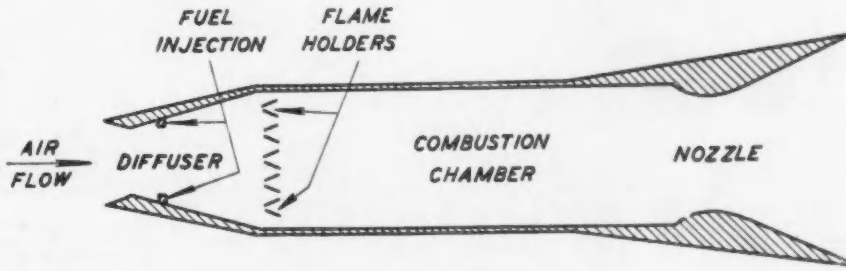


Fig. 1—Cross-section of typical ram jet engine

Fig. 2—Mating a ram jet and auxiliary rocket booster just before firing

engine operating at its most effective speed.

These powerplants also deliver very high thrust horsepower for a given engine weight. Car engines generally require several pounds per developed horsepower and large aircraft engines about one pound of engine to develop 1 hp. Ram jet weights are measured in small fractions of an ounce to develop a thrust horsepower.

Drawback with the ram jet is that it needs an auxiliary powerplant to accelerate it to flight speed. Its mode of operation, explained in terms of Fig. 1, shows why.

The ram jet is a pipe with a slowly diverging duct, followed by a constant cross-section area and ending in a simple nozzle. The constant area is the combustion chamber and the air intake at the opposite end. If a combustible gas is ignited in the combustion chamber, this simple ram jet doesn't move. Expanding gas will rush out both ends with no reaction on the body.

But if we accelerate the ram jet to a high speed and then start combustion, expanding gases will meet resistance from incoming air at the nose. The burned gases, seeking the path of least resistance, exhaust out of the rear exit. These gases create a "heat plug" which maintains pressure at a higher level in the cone frustrum of the diffuser. This pressure on the frustrum projected area creates thrust in the desired direction. Reaction of this compressed or rammed air at the nose, followed by rearward exhaust of high-speed gas, gives the ram jet its name.

To get the ram jet up to speed so that it can function, it needs an auxiliary accelerating device. One way to get this boost is with a rocket. See Figs. 2 and 3.

The rocket also looms important as a primary engine. The German V-2 illustrates the potential of this type engine. This rocket is fuelled by alcohol and oxygen. It can develop a top speed of 3400 mph. At top speed, this engine develops about one-half million thrust horsepower and consumes nine and one-half tons of fuel in about 1 min. Fuel consumption is the rocket's chief drawback.

Although it doesn't have the difficulty with thrust delivery at low speeds of the ram jet, the rocket consumes fuel several times as fast as the ram jet. That's because the rocket must carry both fuel and an oxidizer for burning the fuel. The ram jet takes oxygen from the ram air.

Oxidizer and fuel must be stored in separate tanks and burned in a third compartment in rockets using liquid propellants. In solid fuel rockets, both fuel and oxidizer are stored as well as burned in one tank. See Fig. 4.

Because it carries both oxidizer and fuel, the rocket is not earth-bound. Yet current availability of only chemical propellants limits the possibility of interplanetary travel. Perhaps atomic energy rockets hold the answer. (Paper "Rocket and Ram Jet Supersonic Powerplants," was presented at SAE Washington Section, Oct. 18, 1949. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

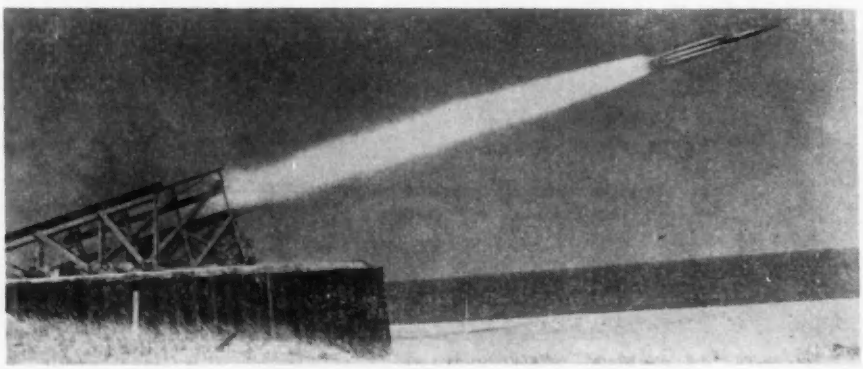


Fig. 3—A combined rocket and ram jet in flight. The rocket usually is jettisoned as soon as the ram jet reaches flight-sustaining speed

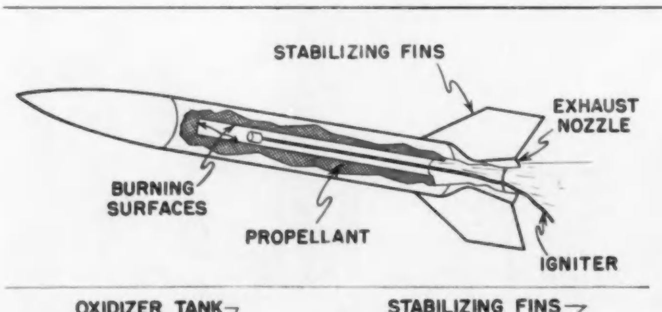


Fig. 4 — Rocket fuelled by solid propellants uses the single fuel storage compartment as the combustion chamber, as shown above. In the liquid fuel rocket, below, oxidizer and propellant are stored separately and brought together to burn in a third chamber

Engineers at G. E. Get Broad Training

Excerpts from paper by

GEORGE D. DOWNING

General Electric Co

HELPING the young engineer understand the many, many facets of the engineering profession—helping him to be a happy round peg ably filling his round hole—is an important challenge to the engineering profession.

At General Electric, we do not hire engineering graduates for specific jobs. All young engineers spend their first year to year and one-half in the testing department, following the so-called "Test Course." While on the Test Course, the young engineer is given rotating assignments of three months duration in which he actually performs, under competent supervisors, engineering tests on our products.

He gets a bird's eye view of all company activities, except perhaps sales—and we now give to about 20% of our new men a 3-months assignment in a district sales office before coming to the Test Course.

The young engineer is rated at the end of each three months' assignment, and is given close attention and counsel by capable engineers in the personnel department.

While he gains practical experience in the factory, he also attends a course of classroom instruction, the so-called General Course.

This basic program is at least a step toward the solution of his first problem: "What kind of engineering work shall I get into?"

If this problem is solved, he immediately faces the second one: "How can I train further in this specific

Continued on page 93

TECHNICAL COMMITTEE *Progress*

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H. T. Youngren

Materials Men Meet

THE SAE Aeronautical Materials Specifications Division will hold its next meeting at the Olympic Hotel in Seattle, Sept. 11-15.

Copies of the agenda listing specifications to be discussed in open sessions at the meeting are available to interested parties from the SAE Aeronautical Department.

Committee Personnel Changes

AMONG the technical committee personnel changes approved recently by the SAE Technical Board are:

1. Designation of the following Board members as committee sponsors:

B. B. Bachman, Autocar Co.—SAE Brake Committee and SAE Highways Research Committee.

R. J. S. Pigott, Gulf Research & Development Co. — SAE Fuels & Lubricants Committee.

Harry Bernard, Mack Mfg. Corp. —SAE Non-Ferrous Metals Committee.

A. T. Colwell, Thompson Products, Inc.—SAE Parts & Fittings Committee.

C. T. Doman, Ford Motor Co.—SAE Engine Committee.

G. A. Delaney, Pontiac Motor Division, GMC—SAE Screw Threads Committee and SAE Lighting Committee.

R. R. Teetor, Perfect Circle Corp. —SAE Surface Finish Committee.

2. Additional SAE representatives recommended for appointment on the joint SAE-ASTM Technical Committee on Automotive Rubber are: B. F. Jones, Autocar Co.; J. M. Reynar, GMC Truck & Coach Division; A. C. Darroch, International Harvester Co.; R. K. Jack, Reo Motors, Inc.; and V. C. Speece, White Motor Co.

3. J. M. Campbell, Research Laboratories Division, GMC, recommended to succeed J. D. Klinger, Chrysler Corp., as an SAE representative on ASA Sectional Committee Z11 — Petroleum Products and Lubricants.

4. R. D. Kelly, United Air Lines, Inc., to succeed Arthur Nutt as chairman of the SAE Aeronautics Committee.

5. R. F. Holmes, AC Spark Plug Division, GMC, to succeed W. L. Barth as SAE representative on ASA B2—Pipe Threads.

6. W. Wiers, Fisher Body Division, GMC, as SAE representative on ASA B32—Wire and Sheet Metal Gages.

7. S. E. Knudsen, General Motors Corp., as SAE representative on ASA B55—V-Belts and V-Belt drives (except automotive and agricultural).

8. The SAE Screw Threads Committee elected T. M. Logan, Caterpillar Tractor Co., as chairman, to succeed W. L. Barth. R. F. Holmes, AC Spark Plug Division, GMC, was appointed vice-chairman to succeed H A. Marchant, Chrysler Corp.

Technishorts . . . .

NUTS AND BOLTS: Interchangeability of American, British, and Canadian Hexagon-head bolts and nuts is near. Negotiations among standardizing bodies of the three nations are approaching final agreement.

This unification effort covers nuts and bolts in the regular series up to the 2-in. size. These nuts and bolts will embody the already agreed-upon Unified screw threads now standard in the three countries. American Standard B18.2-1941 will be revised accordingly when final agreement on nuts and bolts is reached. The SAE Screw Threads Committee is expected to revise the SAE standard on regular nuts and bolts to conform with the American Standard. (Changes are expected to be minor.)

TRUCK NOISE: A report on automotive traffic noise and its measurement recently was approved by the SAE Technical Board. The report covers a study undertaken at the request of the Automobile Manufacturers Association and conducted by the Automotive Traffic Noise Subcommittee of the SAE Motorcoach and Motor Truck Committee.

The Subcommittee's work, it is expected will be reported by Paul Huber, Fram Corp., at a symposium on automotive traffic noise at the SAE National Transportation Meeting, New York, on Oct. 16. Chairman of the Subcommittee is F. B. Lautzenhiser, International Harvester Co.

Rosen Honored

JAMES Clayton Lecturer for 1950 is C. G. A. Rosen, Caterpillar Tractor Co. The Clayton Lectures, sponsored by the British Institution of Mechanical Engineers, are designed to promote the advancement of knowledge in fields related to mechanical engineering. Each year the Institution selects a distinguished engineer or scientist of world reputation to present the Lecture. Rosen plans to leave New York on October 22 to present the Lecture at the Institution's meeting in London on November 14. His subject will be "Significant Contributions of the Diesel Research Laboratory."

Rosen has been a member of the SAE Technical Board, and was SAE Vice-

President representing Diesel Engine Activity in 1940 and SAE Councilor in 1943-44.

1951 Handbook Larger

IN 1951, the SAE Handbook will be increased in size from 5½ x8 to 8½ x 11 in., as a result of a survey made of SAE technical committee members.

Half of those responding to the inquiry replied that the Handbook would be equally useful to them in either size. Of those expressing a preference, the proportion was three to two in favor of the increased Handbook size. An item published in the May, 1950 issue of the SAE Journal invited all members to submit their opinions. It brought a response favoring a switch to the new size.

After reviewing the results of the survey and the pros and cons of the change, the Technical Board decided to adopt the 8½ x 11 in. page size for the Handbook.

Tractor Design Molded To Accessory Demands

Based on paper by

J. M. DAVIES

Caterpillar Tractor Co.

GROWING use of accessories has forced changes in track-type tractor design. The bulldozer, scraper, front-end and overhead loaders, and pipe-laying attachments are cases in point.

Mutual changes were required in both the parent tractor and bulldozer as they developed. As a result of dozer needs, several changes took place . . . . the modern tractor with heavy roller frame structures for convenient attachment of dozer push blades, new transmissions with separate forward-reverse shifting arrangements, and improved tractor balance.

The self-loading scraper has demanded high drawbar pulls and performance of large track-type tractors. Push-loading of scrapers with a dozer blade or push block dictated detailed attention to structural designs of both equipment and tractor arrangement.

Front-end and overhead loaders called for stability and structural strength to support heavy loads this equipment imposed on tractors. Tractors were in distress with pipe-laying attachments, until they were designed to absorb and counterbalance the loading in this service. (Talk, "Influences of Accessory Equipment on the Design of the Modern Track-Type Tractor," was presented at SAE Chicago Section, Feb. 14, 1950.)

SAE Shot Peening Group For Method to Forecast

ONE phase of the SAE Shot Peening Division's program for advancing the shot peening and blasting art (for increasing fatigue life and cleaning forgings and castings) is aimed at establishing a uniform procedure for predicting shot life. Object is to simulate actual service conditions, as closely as possible, in accelerated laboratory and production acceptance tests.

Many obstacles must be hurdled to develop a uniform test procedure acceptable to all shot suppliers and users. First, types of shot used and conditions of usage vary from plant to plant, so that it's tough to come up with a representative test. Second, the test must be inexpensive and take little time to perform.

In its search for a suitable procedure, the Division has studied four shot life-testing machines, each of which differs somewhat in test method required, though the basic principles used in all are the same. They are: the Pangborn machine, the American Wheelabrator tester, Alloy Metal Abrasive machine, and the Mattson-Cargill shot tester.

Discussions at a recent meeting of the Division brought to light some of the thinking on laboratory experience with shot life-testing procedures and machines. Here is what some of the members said:

J. F. Ervin, Alloy Metal Abrasive Co.: "We have developed the following method of determining shot quality: One hundred grams are initially placed in our testing machine. (This machine is described in SAE Journal, October, 1949, pp. 45-47, "New Machine Evaluates Blasting Material Life.") The machine is run until no more than 10% of the material is dissipated. After the remaining material is weighed, enough new material is added to get the machine up to the original charge. This duplicates the operation in a blasting machine. This procedure is continued until 300 grams are used by this addition method.

"The number of passes or breakdown cycles the material resisted during this period is measured. The average amount added per every 100 passes during the last 100 g is used as a comparing factor. The shot actually approaches a stabilized condition in the tester as the shot in a production installation does. This method compares one breakdown rate against another.

"The test should be as identically correct as the 55% breakdown line presently used is correct. It gives an addition rate while the present method gives the average life of the particle sample."

J. C. Straub, American Wheelabrator & Equipment Corp.: "We have found the rate of breakdown of shot to be the reciprocal of its average life. I believe there is a relationship between the tester and production machines, but it is not at all a simple one. For a given shot, the speed-breakdown curve for the tester is parallel to that for a full-sized machine. But this does not mean that two types of shot will give parallel curves in either machine. A great deal more data are needed before we can predict shot usage by means of a shot tester."

Searches Shot Life

H. W. Vange, Process Development Section, GMC: "Tests in a production machine under laboratory control do not substantiate the results from a shot life test machine to any degree of accuracy. The shot life test machine will indicate the relative quality of various samples of the same shot type.

"Results from various shot types (as cast steel versus cut wire) cannot be projected to estimate comparative usage in a production machine. Life testing equipment currently in use will not give results accurate nor representative enough to be used as a basis for predicting life in a production machine."

N. S. Mosher, Alloy Metal Abrasive Co.: "There are many variables in a production machine. We can only be interested in a comparative life between shot types. The first breakdown is only to get rid of the faulty shot and the test should be based on what might be called the 'good' shot only. Incidentally, Mr. Ervin's method is based only on this 'good' shot."

T. F. Butler, Ford Motor Co.: "A good comparison can only be made after the shot is in a stabilized condition. First additions are up and down or very unstable and should be excluded from the actual test comparison."

D. A. Cargill, Precision Shot Co.: "In the past it has never been known that actual production costs were predicted from shot life testing machine results. This should not be construed to mean that predictions as to general shot blasting costs cannot be made by the use of shot life testing machines. Most all developments in the manufacture of new shots have been brought about by the indications of improved production costs that shot life testing machine data have disclosed.

"A better shot as shown by a test machine is with few exceptions, a better shot in a production machine. The accuracy of the reflection of the superiority of a shot as indicated by the test machine is determined to a large extent by the condition of the production equipment in which the shot is used."

W. I. Gladfelter, Pangborn Corp.: "Our organization has run tests to determine the conversion factor necessary to use life test results, obtained with a shot tester, for a production machine.

"The consumption rate was known for one shot type in the production machine. Almen strips were mounted on the production machine and passed through wheel streams to determine the peening intensity in the production machine with the shot being used. The problem was to determine the probable consumption when using two other type shots.

"The shot tester was then set at the proper speed to give the same peening intensity on an almen strip in a shot tester using the same shot as in the production machine and number of passes determined to breakdown until 55% passed through a .010 screen.

"Two other types of abrasive were then checked in shot tester, first setting tester to give same peening intensity as above and number of passes determined.

These usages did approximate the prediction. They were:

Production Machine	Life Tester
6.1 lb per wheel hr.	3200 passes
17 lb per wheel hr.	1200 passes
37 lb per wheel hr.	450 passes

"The tests were run with no abnormal losses or carry out."

W. L. R. Steele, Eaton Mfg. Co.: "I would suggest one other method of testing the quality of shot samples. It consists of running samples for a given period of time in the Ervin type machine and then weighing the dust residue in the sack. This weight would be proportional to what a production machine would use except for carry-out and throw-out."

Chairman R. L. Mattson, Research Laboratories Division, GMC: "It seems to me that 'cleaning capacity' should not be confused with shot life as we test it. A soft shot might have a long life, but poor 'cleaning capacity' for certain kinds of work.

"We have come a long way since we started this work in 1945 and there is agreement on the factors. For example, we agree that shot particles should be broken down by striking a target at velocities comparable to that in production machines and we agree that we should measure the number of times the particles can stand such punishment.

"The three methods described differ little in principle but do differ in technique; hence, the resolution of these differences should not be too difficult. I suggest that the three methods outlined by Messrs. Ervin, Straub, and Steele be circulated among the Division membership for further consideration. They constitute a good place to start on an SAE life testing specification."

About

GORDON

CRAWFORD

JOHN F. GORDON has been made vice-president in charge of the Engineering Staff of General Motors. Formerly general manager of Cadillac, he succeeds SAE Past-President **JAMES M. CRAWFORD,** who is on a disability leave of absence. . . . Crawford is convalescing from an extended illness at his home. When able to return to work, he will continue as a member of GM's Engineering Policy Group and will be given other engineering assignments. . . . Gordon started at Cadillac as a laboratory technician in 1923, became chief engineer twenty years later. In 1946 he was named general manager. During World War II, he was transferred to GM's Allison Division.

CHARLES FROESCH, chief engineer of Eastern Airlines, Inc., has just been appointed a member of the Committee on Aeronautics of the Research and Development Board, Department of Defense. He will succeed **WILLIAM LITTLEWOOD,** vice-president-engineering, American Airlines, N. Y., who resigned recently because of illness. Froesch was an SAE vice-president in 1946.

JOHN C. HOLLEY has been appointed vice-president in charge of sales with the Holley Carburetor Co., Detroit, Mich., as announced by **GEORGE M. HOLLEY, JR.,** vice-president and general manager of the company. John C. Holley attended Cornell University and entered the Army in 1942. He began his formal training at Holley Carburetor Co. in the engineering department before the war, and has been a member of the board of directors since 1946. For the past year he has been general sales manager.

J. H. HUNT, General Motors Corp., Detroit, was awarded a certificate for his outstanding service in standardization by the American Standards Association, on June 22. Hunt, who served on ASA's board of directors from 1947 through 1949 as SAE nominee, received the certificate in appreciation of his contribution to standardization, not only in his own company and industry, but particularly in development of American Standards. He was SAE president in 1927.

C. S. DAVIS, JR., has been appointed president of Borg-Warner's Norge Heat Division, with central offices in Detroit. Prior to this, he had been vice-president and general manager of Norge Heat, since it was founded as a separate division of Borg-Warner in January, 1946. He is a son of **C. S. DAVIS,** chairman of the board of Borg-Warner.

T. B. RENDEL, Shell Oil Co., is in England on a combined business and pleasure trip. He will return to New York about the middle of September. Rendel is chairman of the SAE Publication Committee.

HAROLD H. WARDEN has been appointed general sales manager of the Propeller Division of the Curtiss-Wright Corp., Caldwell, N. J. He replaces **R. ELMER MINTON,** who recently resigned from the company. Warden, who has a broad background in the aviation industry, was promoted to his new post from the position of manager, installations department, which he had held for nine years. An active member of SAE Met Section, Warden is well known in the aviation industry for his technical articles and papers.

EDWARD A. OEHLER, formerly factory manager of the Linn Mfg. Corp., Morris, N. Y., is now factory manager of The Ward La France Truck Corp., Elmira Heights, N. Y.

ALWIN A. GLOETZNER, manager of the southeastern zone at Washington, D. C., for the New Departure Division of GMC, retired effective July 1. He was a graduate of Carnegie Tech, and first became an apprentice with the Western Electric Co. He was successively purchasing agent of the Olds Motor Works, chief engineer of Chalmers Motor Co., president and general manager of the Covert Gear and Mfg. Co., and did consulting work until joining New Departure in October, 1939. His retirement marked the discontinuence of the New Departure Washington office. He was chairman of the SAE Washington Section (1946-47).

About SAE Members

DR. EDWARD WARNER was unanimously re-elected for a three-year term as president of the council of the International Civil Aviation Organization. The election took place at ICAO's Montreal headquarters during the first meeting of the new council chosen by the ICAO Assembly two weeks ago. Dr. Warner was born in Pittsburgh, Pa., in 1894, and was educated in Boston at Harvard and at the Massachusetts Institute of Technology. He is the author of many technical books and articles on aviation, and was SAE president in 1930. In 1949 he was awarded the Guggenheim Medal "for pioneering in research and a continuous record of contributions to the art and science of aeronautics."

COLIN CARMICHAEL, Machine Design, is co-editor of the new two-volume edition of Kent's Mechanical Engineers' Handbook. One volume, edited by Carmichael, covers design and production; the other, power. Among the contributors to the 1950 edition are **R. W. BOLZ**, Machine Design; **S. L. CRAWSHAW**, Western Gear Works; **C. K. DONOHO**, American Cast Iron Pipe Co.; **J. M. LESSELLS**, Massachusetts Institute of Technology; **G. PALMGREN**, SKF Industries, Inc.; past-president **R. J. S. PIGOTT**, Gulf Research & Development Co.; **E. F. RIESING**, Firestone Industrial Products; **R. A. RICHARDSON**, Research Laboratories Division, GMC; **W. O. SWEENY**, Haynes Stellite Co.; **A. F. UNDERWOOD**, Research Laboratories Division, GMC; **W. G. WALTERMIRE**, Lamson and Sessions Co.; and **S. J. WILLIAMS**, National Safety Council. The Handbook is published by John Wiley & Sons, Inc. Price of each of the two volumes is $8.50.

REINOUT P. KROON, Dutch-born engineering manager of the aviation gas turbine division, Westinghouse Electric Corp., Philadelphia, Pa., was awarded the Spirit of St. Louis Medal of the American Society of Mechanical Engineers on June 21, for leadership in the development of the first American design of a turbojet powerplant for aviation service. The medal was presented at a banquet during the Society's five-day semi-annual meeting in New York.

HAROLD A. STRICKLAND, JR., is now connected with Hotpoint, Inc., Chicago, Ill., in the capacity of administrative engineer. Prior to this, he was executive engineer with The Budd Co., Detroit, Mich.

ROBERT H. KERRUISH, formerly employed as a design engineer with the G & D Mfg. Co., Streator, Ill., has taken another position with the National Lock Co., Rockford, Ill., as a design engineer in the refrigerator hardware department.

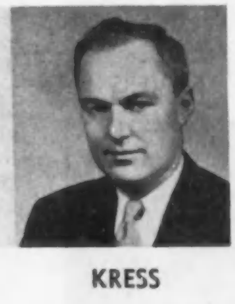
DAVID T. SICKLESTEEL has been promoted from chief engineer of Detroit Gear Division, Borg-Warner Corp., to vice-president in charge of engineering, Detroit Gear Division.

ERNEST ZUMSTEG, executive assistant, Non-Vehicle Products, General Motors Suisse S. A., Bienne, Switzerland, has been elected a member of the board of directors of that company.

WALTER I. BUCHANAN has been appointed to the position of sales manager of the service parts division of Spicer Mfg. Division of Dana Corp., Toledo, Ohio. **DAVID F. KALISH**, formerly sales manager will continue with the company on field sales assignments. Buchanan joined the Spicer organization in 1948, as assistant sales manager of the service parts division. He is a native of Illinois and a 1930 graduate of the University of Illinois.

FURBER MARSHALL has been elected president and **RALPH H. KRESS**, executive vice-president, of the Dart Truck Co., Kansas City. Marshall is the president of Carlisle Corp., of which Dart Truck Co. is a wholly owned subsidiary. He has been a director of Dart. Kress was formerly associated with General Motors for eleven years as specification engineer for the national fleet department of Chevrolet Division.

MARSHALL



KRESS

JOHN W. COCHRUN, formerly with Bendix-Westinghouse Automotive Air Brake Co., has been appointed equipment service manager of The DeVilbiss Co., Toledo, Ohio. The company has set up this position to concentrate other activities in all divisions of the company which come under customer service. Cochrun is a Purdue University graduate with many years of experience in service training and administration.

JAMES H. BARNES has been employed by The Timken-Detroit Axle Co., Detroit, Mich., as a member of the sales engineering department. Former purchasing agent of the Lincoln-Mercury Division, Ford Motor Co., Barnes was previously associated with the Budd Co. for more than 30 years.

ROSS D. GROVER is now employed by the Nast Motors Division of Nash-Kelvinator Corp., Detroit, Mich., as a technical engineer in the technical advertising department. He was formerly in charge of chassis design for the Tucker Corp., Chicago, Ill.

LLOYD F. COATES, formerly sales manager with Maggiora Chemical Co., Los Angeles, Calif., is now connected in a similar capacity with the Chem-Therm Mfg. Co., Pasadena, Calif.

ALEXANDER T. BURTON is returning to the home plant of North American Aviation, Inc. in Los Angeles, Calif., after nine years as their eastern representative in Washington. He will take over a newly-created post as assistant to the president, coordinating sales and customer relations.

GEORGE P. HENDERSON, Auto Gear & Parts Co., Philadelphia, Pa., has been appointed chairman of the finance committee, for the Middle Atlantic Regional Automotive Show, Inc., to be held in Philadelphia's Commercial Museum, April 24 to 27, next year.

WILLIAM F. STOERMER is now with the Aero Supply Mfg. Co., Inc., Corry, Pa., as a development engineer. Previously, he was employed as a development engineer by Pesco Products Division of Borg-Warner, Bedford, Ohio.

ERVIN V. ANDREWS, JR., prior to this, a salesman for the International Harvester Co., Denver, Colo., is now a branch manager for Reo Motors, Inc., Kansas City, Mo.

SMITH

SILVERS

TEMPLE C. SMITH, engineer of motor vehicles and construction apparatus for the American Telephone and Telegraph Co., has retired after almost 40 years of Bell System service. Smith has been active in SAE, serving as vice-president, chairman of Met Section and SAE Highway Research Committee, and member of its Technical Board, Fuels & Lubricants and Transportation and Maintenance Committees, and in the ASTM and ASA. Smith has been succeeded by **RAYMOND C. SILVERS**, who has an extensive background of experience in both telephone engineering and construction work as a result of his 38 years of service in the Bell System.

DONALD R. DIGGS, previously an instructor in mechanical engineering at Northwestern University, is now employed by E. I. Du Pont de Nemours & Co., Deepwater, N. J. as a mechanical engineer.

JEAN W. ARNOLD is now manager of production engineering with Ford Motor Co., Highland Park, Mich. Prior to this, he was general superintendent of manufacturing with the Clark Equipment Co., Jackson, Mich.

STEPHEN R. NEMETH, formerly a graduate student at Rensselaer Polytechnic Institute, is now employed by E. I. Du Pont de Nemours & Co., Inc., as an engineer in the technical section.

EARL ROBERT HINZ is now an Aerodynamicist "A" with Consolidated Vultee Aircraft Corp., San Diego, Calif. Prior to this, he was an associate scientist and instructor at the University of Minnesota.

FREDERICK A. DOBBRATZ, previously an engineer with H. L. Yoh Co., Philadelphia, Pa., is now employed as a stress analyst with Lockheed Aircraft Corp., Burbank, Calif.

WILLIAM BERLINER, who was formerly a test engineer with General Electric, Bloomfield, N. J., is now employed by the aircraft gas turbine division of General Electric, Cincinnati, Ohio, as shift supervisor of engine test, including engineering, production and personnel problems.

WALTER F. WHITEMAN, formerly chief engineer of Wm. & Harvey Rowland, Inc., has joined the Brockway Motor Co., Inc., Philadelphia, Pa., in their service department, and is doing liaison and service engineering work.

KENNETH IAN MORTON, formerly a service mechanic with the White Motor Co., Cincinnati, Ohio, is now employed by the Lima-Hamilton Corp., Hamilton, Ohio, as an erector in the diesel division.

DAVID J. OAKLEY, formerly a student at Rensselaer Polytechnic Institute, is now employed by the Owens-Corning Fiberglas Corp.

HENRY H. HOMITZ, who graduated in January from Case Institute of Technology, is now in the service department of Dictaphone, San Bernadino, Calif.

ROBERT C. BIRKS, who graduated in February from Indiana Technical College, is now connected with Birks Electric Service, Logan, Iowa.

ROY PETERSEN is a heating engineer with the Milwaukee Gas Light Co., Milwaukee, Wis. He graduated last December from Marquette University.

HOLLIS S. DOLAN, formerly division sales manager with The Pennzoil Co., Los Angeles, Calif., is now a motor car and truck dealer in Corona, Calif.

GENE STEINKAMP, formerly general sales manager of James Bryant Motors, Inc., is now sales representative for Thomson Bros., Inc., Cincinnati, Ohio.

WILLIAM D. GAUTHIER, a June graduate of Chrysler Institute of Engineering, is now employed in the engineering division of Chrysler Corp. as an electrical engineer.

GRANT S. WILCOX, JR., assistant factory manager of Plymouth Motor Corp., is the new president of the Engineering Society of Detroit. He took office July 1, as the youngest president in the organization's history. He is 40 years old. Other officers elected were **J. L. MC CLOUD,** Ford Motor Co., first vice-president, and **F. P. ZIMMERLI,** Associated Spring Corp., second vice-president.

JOHN A. AWALT is now employed by Western Metal Products, Phoenix, Ariz., as a sheetmetal mechanic. Prior to this, he was a student at the Academy of Aeronautics.

LORNE W. HAMILTON, formerly a service superintendent with Begg Brothers, Ltd., Vancouver, British Coulmbia, is now engaged in service promotional work and the reorganization of Chrysler dealers' service departments in British Columbia and Alberta, for the Chrysler Corp. of Canada, Ltd., Windsor, Ontario.

JOHN F. GORDON, vice-president of General Motors and general manager of the Cadillac Motor Car Division, delivered the commencement address to the graduating class of the Babson Institute, Babson Park, Mass., on June 17. Speaking to Babson graduates on the subject, "Opportunity Is An Individual Responsibility," Gordon urged the seniors to continue laying the groundwork for their future success by applying the sound and proven principles which have served to create the American way of life.

REX B. BEISEL, formerly general manager of Chance Vought Aircraft, division of United Aircraft Corp., Dallas, Texas, is now engaged in business surveys in Dallas.

WALTER J. OLIVER is now with Francis S. Haberly, Chicago, Ill.

ROBERT A. WILLSON, formerly a student at Tri-State College, is employed by the Wright Division of the American Chain & Cable Co., York, Pa. as a sales engineer.

WALTER E. SHIVELY, manager of tire design for the Goodyear Tire & Rubber Co., Akron, Ohio, was honored by company executives here when he was presented a pearl service pin marking 35 continuous years with the company. Making the presentation was **DR. R. P. DINSMORE,** vice-president in charge of research and development for Goodyear.

DINSMORE

SHIVELY

CLARK E. MOSER, who graduated last January from the University of Southern California, is now inspector with the Department of Building and Safety, Los Angeles, Calif.

SHERLOCK A. HERRICK, JR., will be employed as a test engineer with the Worthington Pump & Machinery Corp., Buffalo, N. Y., as of September 5.

LEWIS H. HUGHES, a May graduate from the University of British Columbia, is now a mechanical engineer with the International Harvester Co. of Canada.

MARK DICK, who graduated in June from Oregon State College, is now with Universal Oil Products Co., Riverside, Ill., as an automotive test engineer.

JAMES F. ASMUS, who, prior to this, was a student at Northrop Aeronautical Institute, is now affiliated with the training squardon at the Goodyear Aircraft Corp., Akron, Ohio.

RAYMOND PROSSER, formerly superintendent of fleet maintenance with the Inland Empire Refineries, Spokane, Wash., is now connected with the Arrow Transportation Co., Portland, Ore. in a similar capacity.

LT. COL. M. A. KINLEY is now connected with the Detroit Arsenal, Centerline, Mich. Prior to this, he was with the military department at the University of Michigan, Ann Arbor, Mich.

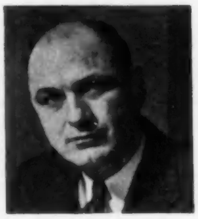
JOSEPH T. REAM, JR., who graduated from the University of Illinois this past June, is now a mechanical engineer in the maintenance department of Union Carbide and Carbon Corp., South Charleston, W. Va.

RUSSELL L. GIBSON, formerly president and managing director of Cub Aircraft Corp., Ltd., Hamilton, Ontario, has become president of Cub Flyers, Ltd., and Metallurgical Sales and Service Co., both of Hamilton.

LEWIS K. MARSHALL has been appointed field relations representative for the Lincoln-Mercury Division of Ford Motor Co. In his new assignment, he will serve as a special staff representative of the operations manager in maintaining liaison with plants, sales offices, and selected dealers and customers for the purpose of appraising general conditions in the field which concern product quality and acceptance, dealer-factory relations, and customer-dealer relations. Since the end of World War II, Marshall has been president of Northeast Motors, Inc., a Ford dealership in Portland, Maine.

JOHN W. WHITE, who is now retired, reports that, aside from playing golf, he now has a well equipped shop of precision tools in his home and develops various small products which he puts on the market on a royalty basis. He has also done considerable government work and some automotive development along hydraulic lines.

THOREN



POMEROY

T. R. THOREN has been appointed engineering manager of Thompson Products, Cleveland, Ohio. In this capacity he will assist the vice-president in staff duties of development, new product investigations and division engineering coordination. **A. L. POMEROY** has also been appointed director of development. In this capacity he will have charge of all dynamometer test work, new product design, and staff field testing. The announcement was made by **A. T. COLWELL**, vice-president of Thompson Products.

ROBERT J. NAGLE II, formerly a student at the University of Colorado, is now a lighting engineer with the Southwestern Gas and Electric Co., Shreveport, La.

ERNEST I. WROBLEWSKI, who graduated in February from Purdue University, is employed as a process engineer-trainee by the International Harvester Co., Louisville Works, Louisville, Ky.

GERALD H. DICKINSON, a June graduate from Bradley University, is now employed in the purchasing department of The Oliver Corp., Shelbyville, Ill.

KENNETH C. BELL is a mechanical engineer with The Electric Auto-Lite Co., Toledo, Ohio. He graduated in June from Case Institute of Technology.

DAVID C. HOUSE, who was formerly a student at Cal-Aero Technical Institute, is an engineer with Boeing Airplane Co., Seattle, Wash.

ROY G. MITCHELL, JR., an August graduate of General Motors Institute, is employed as a process engineer in Cleveland, Ohio.

VIRGIL W. KUNS, a recent graduate of Northrop Aeronautical Institute, is employed by The Texas Co., Los Angeles, Calif., as a draftsman-clerk.

MURRAY GALBRAITH is now with Fairbanks, Morse & Co., Toronto, Ontario. He was formerly a student at the University of Toronto.

MERTON A. SIGODA, who graduated last January from Massachusetts Institute of Technology, is now a research engineer with the Man-Sew Corp., New York.

ROBERT W. GIERTZ, who is a June graduate of the University of Illinois, is now a student engineer with the John Deere Waterloo Tractor Works, Waterloo, Iowa.

FRED G. EDWARDS is now a mechanical engineer on diesel combustion studies with the U. S. Bureau of Mines, Bartlesville, Okla. He graduated this past June from the University of Oklahoma.

ROBERT A. DORSHIMER is employed as a graduate engineer in training by the Oldsmobile Division of GMC, Lansing, Mich. Prior to this, he was a student at Rensselaer Polytechnic Institute.

WALTER J. LE BEL, who graduated last June from the University of Maine, is now employed by the S. D. Warren Co., Westbrook, Maine, in the maintenance and machine shop.

JOSEPH G. DICKINSON, a June graduate of Purdue University, is now in the engineering department of the Carnegie-Illinois Steel Corp., Gary, Ind.

EUGENE E. FLANIGAN is now connected with the General Motors Research Laboratories Division, Detroit, Mich. He graduated last June from Purdue University.

WILLIAM O. HALL, a June graduate of the University of Colorado, is with the C. A. Norgren Co., Denver, Colo., in the capacity of product design and development engineer.

S. E. ELLERBE, formerly manager of the service and parts departments for Liddon White, Inc., Nashville, Tenn., is now in charge of engineering and production with the Safety Tire Gauge, Inc., Atlanta, Ga.

CHARLES B. BUNCH is field service representative for AiResearch Mfg. Co., Los Angeles, Calif. Prior to this, he was sales and service representative for The B. G. Corp., New York.

JOSEPH GESCHELIN, past vice-president SAE, Detroit editor Chilton publications, has been appointed chairman of the Public Relations Committee of the Engineering Society of Detroit.

CHARLES R. RACINE is a field engineer with the Magnaflux Corp., Chicago, Ill. Previously, he was with the General Motors Acceptance Corp. in

HERMAN S. FESSLER, who is with the U. S. Air Conditioning Corp. as an engineer design draftsman, graduated from the University of Minnesota in March.

JOSEPH C. BEHNE, JR., a June graduate from Texas A & M College, is now employed as an engineering trainee by Chance Vought Aircraft, Dallas, Texas.

WILLIAM V. MOFFAT, who graduated in February from Purdue University, is a draftsman "B" with Douglas Aircraft Co., El Segundo, Calif.

RALPH J. WEHRMAN, a June graduate of Ohio State University, is a college graduate in training with the Research Laboratories Division, GMC, Detroit, Mich.

EUGENE ROBERT GANSSLE, a recent graduate of Massachusetts Institute of Technology, is a junior mechanical engineer with the Grumman Aircraft Engineering Corp., Bethpage, N. Y.

DAVID A. GORTE is now employed in the drafting training program at Chrysler Corp., Detroit, Mich.

OLEN H. KIRCHMEIER, formerly a student at Oklahoma A & M College, is now employed as an engineer by the Murphy Boiler & Piping Co., Shawnee, Okla.

JOHN W. DORREPAAL, a former student at the University of Toronto, is a junior engineer in the export division of the Ford Motor Co. of Canada, Ltd.

ROBERT W. YOUNG, a June graduate from the University of California, is now a junior engineer connected with the U. S. Geological Survey, water resources division, San Francisco, Calif.

THOMAS RUSH HEATON, a June graduate of Purdue University, is now connected with the National Advisory Committee for Aeronautics, Cleveland, Ohio, in the capacity of aeronautical research scientist.

ROBERT A. FESSER, who graduated last March from Tri-State College, is now connected with the Olds Motor Works, Lansing, Mich.

HAROLD RIEDEL, an August graduate of General Motors Institute, is a student engineer with Fisher Body-General Motors, Cleveland, Ohio.

RAYMOND L. STERN, who graduated last January from Aeronautical University, Inc., is with Armour & Co., Chicago, Ill., as a refrigeration engineer.

ARTHUR R. SHRUMM, a recent graduate of the University of British Columbia, is an engineer—grade I, with the Dominion Public Works, Westminster, British Columbia.

RALPH E. TUTTLE, a June graduate from Case Institute of Technology, is now a trainee in product engineering at Lord Mfg. Co., Erie, Pa.

OWEN A. DARCEY, who graduated recently from the University of Southern California, is now an engineering draftsman "A" with Lockheed Aircraft Corp., Burbank, Calif.

WILLIAM O. HALL, formerly a student at Purdue University, is now a plant engineer with Mid-State Steel and Wire Co., Crawfordsville, Ind.

RICHARD F. THORMAN, who, prior to this, was a student at Tri-State College, is a junior engineer with Bendix Aviation Corp., South Bend, Ind.

H. J. MEYER, formerly a student at Northrop Aeronautical Institute, is an engineering draftsman with North American Aviation, Inc., Los Angeles, Calif.

WILLIAM W. STRONG, a June graduate of Oregon State College, is now a draftsman with the Gerlinger Carrier Co., Dallas, Ore.

RUSSELL SCHUCKER is now with the Skiles Oil Corp., Mt. Carmel, Ill. as an engineer. The company produces crude oil.

THEODORE H. LYMAN is now connected, in the capacity of mechanical engineer in the product research department, with Oscar Mayer & Co., Madison, Wis.

ROBERT R. RUCKER, formerly a student at Cal-Aero Technical Institute, is now a technical illustrator with North American Aviation, Inc., Los Angeles, Calif.

HAYNES CLARK, who graduated last January from Texas A & M College, is now a product engineer with The Lennox Furnace Co., Ft. Worth, Texas.

EMIL J. GASPARINI, a former student at the Academy of Aeronautics, is now an aviation cadet with the U. S. Air Force at San Angelo, Texas.

RICHARD D. BLAKLEY, a June graduate of Chrysler Institute of Engineering, is now employed by Chrysler Corp., Detroit, Mich., as a senior engineer.

THEODORE R. ANDERSON, who was formerly a student at Lawrence Institute of Technology, is now training in the varnish department of The Glidden Co., Chicago, Ill.

JAMES A. GUSKE, a January graduate of Illinois Institute of Technology, is now a development engineer with Holly Molding Devices, Inc., Chicago, Ill.

JAMES L. MONTGOMERY, who graduated last June from Wichita University, is now employed as an engineering draftsman by the Cessna Aircraft Co., Wichita, Kans.

EDWARD H. FAUTH, a June graduate of Michigan State College, is a junior engineer with the Barber Greene Co., Aurora, Ill.

JOHN M. PERKINS, formerly a student at Northrop Aeronautical Institute, is now an engineering draftsman with North American Aviation, Inc., Los Angeles, Calif.

JACK C. JOHNSON, who graduated in June from the University of Colorado, is employed by the Boeing Airplane Co., Seattle, Wash., as a junior engineer.

JOHN H. AMACHER, a June graduate of the University of Maryland, is now a junior engineer with Sylvania Electric Products, Inc., Emporium, Pa.

GEORGE W. DREW, formerly a student at the University of Wisconsin, is now in the research laboratories division of GMC, Detroit, Mich., as a college graduate in training.

MARVIN V. SCHOBER is a technical apprentice with the Pacific Gas & Electric Co., San Francisco, Calif. Prior to this, he was a student at Purdue University.

JOHN G. VALERIO is now a design engineer at the Detroit Arsenal, Centerline, Mich. The company produces tanks and armored vehicles.

GORDON K. WOLFGRAM, who graduated last December from Marquette University, is an engineering draftsman with the Gehl Bros. Mfg. Co., West Bend, Wis.

RALPH E. MOLLOY, a former student at the University of Washington, is a servicing engineer with the Liberty Mutual Insurance Co., Seattle, Wash.

THEODORE J. ADOLPHSEN, who graduated in March from the University of Washington, is now senior engineering aid to the city engineer, Seattle, Wash.

ROBERT W. LORIMER, a January graduate of Rensselaer Polytechnic Institute, is with the Glen L. Martin Co., Middle River, Md., as a tool inspector.

ROBERT F. ANDERSON, formerly a student at the University of Wisconsin, is now a mechanical engineer with the Four A Reel Drive Co., Clintonville, Wis. The company produces trucks.

FIRMER MERRICK is now employed by the Chicago Telephone Supply, Elkhart, Ind., as an apprentice tool and die maker. The company produces radio and television controls.

ADOLPH J. GAWIN, who graduated last February from the University of Illinois, is now connected with the Bell Aircraft Corp., Buffalo, N. Y. in the capacity of development test engineer.

DONALD B. HUNTER, a graduate of California State Polytechnic College, is now employed as a machine operator for the H. L. Harvill Mfg. Co., Corona, Calif.

FRANK P. KLATT is an engineer with Beloit Iron Works, Beloit, Wis. He graduated in June from the University of Wisconsin.

JAMES W. NOLAN, who graduated last June from Purdue University, is with the Peerless Pump Division of the Food Machinery & Chemical Corp., Indianapolis, Ind., as an engineering sales trainee.

JAMES B. HESLOP, a June graduate of the University of Toronto, is employed by Frigidaire of Canada, Ontario, Canada, as a process engineer.

RICHARD A. RANSOME is employed, in the capacity of engineer, by the Central Illinois Electric & Gas Co., Rockford, Ill. He is a June graduate from the University of Illinois.

ALBERT T. REIFF, JR., is a student in the graduate school at the Chrysler Institute of Engineering, Detroit, Mich. He graduated in June from Cornell University.

LESLIE Y. PARFITT, a former student at Tri-State College, is with the Studebaker Corp., South Bend, Ind., as a service engineer.

THOMAS B. FERGUSON, formerly a student at Bradley University, is in training for product design and development with the International Register Co., Chicago, Ill.

DEANE H. MITCHELL, a former student at Purdue University, is now employed by the Allison Division of GMC, Indianapolis, Ind., as a laboratory technician.

WALLACE G. CHALMERS, formerly a student at the University of Toronto, now has a position with Trailmobile Canada, Ltd., Toronto, as sales engineer.

ALEXANDER T. BURTON, after nine years as North American Aviation's eastern representative in Washington, is returning to the home plant in Los Angeles. He will take over a newly-created post as assistant to the president, coordinating sales and customer relations.

GERALD W. HOSTETLER, is in charge of the physical and electrical department at the International Harvester Co., Fort Wayne Works, Fort Wayne, Indiana. Prior to this, he was a senior project engineer with the Kaiser-Frazer Corp., Willow Run, Mich.

Continued on page 100

OBITUARIES

ALMON L. BEALL

Almon L. Beall, one of SAE's and CRC's most active and effective contributors to technical, meetings, and administrative committee work, died on June 17 at his home at Packanack Lake, New York. He had been associated since 1933 with Wright Aeronautical Corp., where he was assistant to the chief engineer at the time of his death.

Through his research work, Beall made continuous contributions to development and improvement of internal combustion engines throughout his career. At Vacuum Oil Co. in the late 1920's he was in charge of quality control of internal combustion engine fuels, and a member of that company's research committee. Earlier he held technical posts with Prest-O-Lite Co., Automotive Service Electric Corp., and Westinghouse Union Battery Co. In recent years at Wright he was particularly active in development work on sparkplugs for aircooled aircraft engines.

Few members of SAE have contributed as consistently and as actively to Society projects as did Almon Beall. He was SAE vice-president for Aircraft Powerplant Activity in 1937—and a Councillor in 1939 and 1940. For more than a decade preceding 1950 he was active on three or more technical committees every year.

In the Coordinating Research Council, Beall was an active participant; his forward thinking and leadership were, in a large measure, responsible for the initiation of some of the most important CRC activities—particularly those involving the performance of aviation fuels and lubricants.

Beall was a member of the CFR Committee for almost 25 years; assisted in the organization of its Aviation Fuels Division in 1933, and continued as a member until the time of his death. He was organizer and leader of the CFR-AFD Civil Aircraft Fuels Performance Group and the CLR Group on Aircraft Gas Turbines and Their Lubrication, and a member of the CFR Motor Fuels Division.

Beall represented the aircraft engine industry throughout World War II on the CRC War Advisory Committee which handled all cooperative fuel, lubricant, and equipment problems for the military services.

He played a major role in development of SAE meetings and membership, having served as chairman of both the National Meetings and National Membership Committees. He was chairman of the Ignition Research Committee and a member of the Aircraft Powerplant Activity Meetings Committee at the time of his death.

Beall was 60 years old.

CHARLES LANIER LAWRANCE

Charles Lanier Lawrance, designer of the engine in the airplane that carried Charles A. Lindbergh on the first solo flight to Europe, died June 24 at his home on Meadow Farm, East Islip, New York.

A pioneer in the aviation field, and inventor of many aeronautical devices, he was one of those men who worked quietly behind the scenes to expand the aviation industry.

As a champion of the aircooled engine, Lawrance was one of the first designers in America to make use of the principle in his Wright Whirlwind engine, a nine-cylinder, radial machine of 225 hp that was used in the "Spirit of St. Louis," Lindbergh's plane, which left Mineola, Long Island, May 20, 1927, landing in Paris the next day.

Lawrance retired in 1946 as chairman of the board of the Lawrance Engineering and Research Corp., Linden, N. J.

He was 68 years old.

C. A. RICHARDS

C. A. "Dick" Richards, who was well-known in the automotive industry as midwest sales manager for the Russell Mfg. Co., Middleton, Conn., died suddenly at his Florida home on June 3 at the age of 56.

Starting as a salesman in Tacoma, Wash., and later as division manager in Atlanta, Ga., Richards had been connected continuously with the Russell Mfg. Co. for the past 25 years. He also operated the Midwest Automotive Warehouse in Chicago.

THOMAS C. FRASER

Thomas C. Fraser died suddenly in May. He was born in Glasgow, Scotland in 1886, and became a U. S. citizen in 1921. He had been automotive superintendent for the Standard Oil Co. of Pennsylvania in Philadelphia. He joined SAE in 1927.

HOWARD M. SMITH

Howard M. Smith, metallurgist at the Ambridge Plant of Wyckoff Steel Co. for the past 26 years, died on June 2, as a result of an automobile crash near Franklin, Pa.

Smith was well known in steel metallurgical circles. He was 54 years old.

RICHARD G. MC ELWEE

Richard G. McElwee, Iron Foundry Division manager of the Vanadium Corp. of America, died June 19 in Niagara Falls, N. Y. He had gone there on a business trip.

While he was with Vanadium Corp., he devoted his time to consulting work with engineers and foundrymen on the development of new materials and consultation on design.

McElwee contributed to SAE meetings as author and panel leader, and was active in technical committee work as chairman of Panel B (Castings) of the Iron and Steel Technical Committee.

He was 60 years old.

JOHN W. BOULTON

John W. Boulton, president and general manager of Unit Parts Co., Oklahoma City, died May 1. He was 55 years old.

Boulton organized the Unit Parts Co. in 1937. He designed and made the tools, jigs and machines and devised the methods of line production for the reclaiming of various automotive units.

He joined the Society in 1938.

DWIGHT W. HUNTINGTON

Dwight W. Huntington, design engineer with Frank Mayer & Associates, Los Angeles, died in February. He was 54 years old.

Huntington was the author of several technical articles which were published in aviation magazines.

He joined the Society in 1944.

OMER L. WOODSON

Omer L. Woodson passed away recently. He was 55 years old. Born in Dalton, Kentucky, he began his career as a mechanic in 1914. At the time of his death, he was director of research for the Radioplane Co., Van Nuys, Calif. He became a member in March, 1945.

HARRY BROWN

Harry Brown died on May 5. He was born in London, England in 1900, and also received his education there. He had been an automotive adviser with the U. S. Army during World War II, and at the time of his death, he was general sales manager for the Nash Motor Co. in Van Nuys, Calif.

WILLIAM H. JOHNSEN

William H. Johnsen passed away on April 6. He was owner of the Technical Chemical Co., Dallas, Texas at the time of his death. He was born in Glencoe, Minn., and educated at LaSalle University. He had been a member since 1943 and was 55 years old.

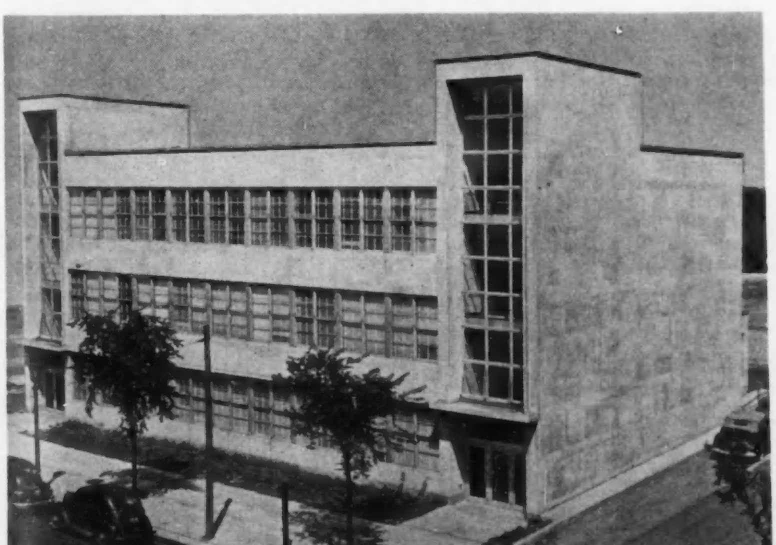
SAE at FENN COLLEGE


Fenn College Tower, 21-story skyscraper, central building of the college

SAE came to the "Campus in the Clouds" just after Germany invaded Poland. War clouds threatened as an SAE Club was being organized in 1939 in Fenn College's 21-story "campus" in the heart of Cleveland. The students, whose interest had been stirred by Professor George V. Parmelee, established the Club firmly before Pearl Harbor.

It was ready to survive instability, accelerated engineering courses, and high membership turnover in the succeeding war years. When fighting stopped in World War II, return of ex-service men brought rapid growth—and the Club became a full-fledged Branch in March, 1946.

Throughout its formative years, the Fenn student group was stimulated by Cleveland Section's interest in its welfare. Norman Hoertz of Thompson Products, 1949-50 Section Chairman, helped materially from 1943 to 1945 when he was chairman of the Section's Student Committee. R. E. Cummings of Thompson, G. E. Tanker of Weatherland, and now E. K. Brown of Crane Packing continued that help as subsequent Section Student Committee chairmen.


The Claude Foster Engineering Building is three stories high, of structural steel and concrete slab construction with an exterior of brick and Indiana limestone similar to Fenn Tower. It is one of the best designed and appointed engineering buildings in the nation, providing a mechanical engineering laboratory, eight classrooms, two drafting rooms and two staff offices

Professor Parmelee left Fenn shortly after Samuel Close was installed as first chairman of the new Branch in 1946—and Professor Donald C. Fabel, assisted by Professor Chester Kishell, took over as faculty adviser.

The Branch continued to hold its meetings in the Fenn College buildings, drew ever more heavily on the industry-speaker resources which its Cleveland location gives. An annual spring banquet and participation with the Case SAE Branch in an annual Cleveland Section Student Meeting came to be yearly program features. Now 10% of Fenn's approximately 1700 engineering students belong to its SAE Branch.

Growth and stability in the Branch are fostered by presence of six SAE members on Fenn's Board of Trustees and by more than 40 alumni now members of the Society. (Earliest alumni to graduate ('30) and latest to join SAE ('50) is Herman J. Troche, vice-president of engineering, J. H. Holan Corp., Cleveland.)

Fenn ranks among the pioneers in cooperative education courses, of which there are now more than 40 in the United States. Five years are required for graduation from its regular Day Division, of which seven semesters are spent working in industry and 12 in classrooms.

The Claude Foster Engineering Building, built in 1948, now complements the Fenn Tower as part of the "campus." The Fenn Tower itself houses a 200-ft steel wire enclosed in

a pipe extending from top to basement —the longest pendulum in the world. Fenn students know the acceleration due to gravity for the Cleveland area very exactly!

Forty-four SAE members attended Fenn College:

Paul Abramoska (1939-41), George J. Atoulikian (1942-46), Joseph J. Berdysz (1940-44), Norman W. Bestor (1936-40), B. C. Bredenbeck (1941-50), Richard S. Brosius (1934-42), A. G. Catlin (1944-45), Robert C. Cornell (1934-39), John W. Douglas (1936-40), George H. Eckels (1937-45), P. G. Edwards (1932-35).

Louis F. Fisher (1939-45), Edward J. Forisch (1931-36), Hans E. Fueger (1939-40), A. D. Gilchrist (1936-43), Robert Gray (1935-42), Robert O. Hickel (1938-42), James A. Hilgendorf (1937-42), Edward J. Hrdlicka, Jr. (1933-38), Harland G. Johnson (1935-39), Carl F. Koenig (1934-39), John Lengel (1946-48).

Mario Charles Lombardo (1949-50), Charles B. May (1939-47), G. E. Meese (1930-35), Donald Yule Milne (1941-43), John F. Murray (1936-44), Robert F. Oster (1935-41), J. M. Pawlechko (1935-42), Donald H. Perry (1938-43), Julius J. Sabo (1945-48), Earl H. Simon (1946-49), Oscar W. Smith (1927-32).

Emery J. Szabo (1937-43), John K. Tomko (1930-33), Herman J. Troche (1926-30), D. E. Votypka (1937-41; 1943-47), Donald P. Williams (1935-40), Harry C. Williams (1937-42), George Wishnek (1940-44), Fred W. Witzke (1940-48), Frederic D. Wyss (1936-40), L. L. Young, Richard H. Zimmerman (1940-43).

25 Years Ago

Facts and Opinions from SAE Journal of August 1925

The chaotic period through which we are passing is the readjustment period brought about by this relatively new form of transportation, the motor vehicle. It must and will find its place in the properly coordinated transportation structure of our country.—A. W. S. Herrington, chief engineer, design section, Motor Transport Division, Quartermaster Corps.

■

Every engineer in the automobile industry should be interested in distribution, because without distribution there will be no engineers.—Ray W. Sherman, editor, Motor.

■

Test results do not bear out the common belief that ductile materials will resist repeated stress better than brittle materials.—F. H. Moore, professor of engineering materials, University of Illinois.

■

The life of ordinary production varnish-finishes can be doubled or quadrupled by the use of color and rubbing varnishes of high durability, but they require a long time for air-drying and forced drying is likely to injure the color.—H. C. Mougey, control chemist, General Motors Corp.

■

Advantages claimed for friction transmissions for automobiles by C. A. Trask, Rockwood Mfg. Co., are: simplicity of handling, silence, high efficiency, capacity for allowing full engine power to be used under all conditions of grade and road, no clashing of gears when changing, ability to shift from high-speed position into reverse with a straight movement of the hand-lever while car is running, and ratio changes so nearly instantaneous that it is seldom necessary to close the throttle when changing.

■

Dr. Ferdinand Porsche, Daimler Motoren Gesellschaft, is an applicant for SAE membership. (Ed. note: He later was designer of Hitler's "Volkswagen.")

■

The SAE 1925 Motor Boat Meeting was held at the Hotel Commodore, N. Y. on August 27.

■

President Horning has stated that an SAE member can perform no better service, both for himself and the Society, than the preparation and presentation of a creditable paper pertaining to a topic that the writer is well qualified to discuss. It is again urged that members offer their assistance to the Meetings Committee and that they do so well in advance of the meeting in which they wish to participate.

American Railway Express Co. each night sends out of New York City from 400 to 500 solid express carloads. Value of these shipments will average around $12,000,000 per day. . . . Would it be strange if, in this great volume, there were enough traffic in small valuable packages that would be glad to avail itself of aviation service? I believe that accelerated transportation of this kind would develop a traffic of its own.—President Cowie, American Railway Express Co.

■

In 1917, SAE adopted as an SAE Standard a 3-in. diameter for tail-lamp glasses. A recent survey of passenger car and motor truck builders' practice shows that of 72 companies submitting data, 27 are using the 3-in. diameter; 19 are using diameters other than 3-in., ranging from 2 to 3½ in.; and 26 are using tail-lamp glasses of special design.

New Englanders Hold Summer Outing

• New England Section
J. S. Walker, Field Editor

June 20—Golf, steak, group singing, and antique and modern auto displays combined to make this one of New England Section's best annual outings.

Forty-five new automobiles were shown, and 20 antique cars of American and foreign makes. Prizes were awarded to winners of an antique auto quiz.

L. T. Clark won first prize for low gross golf score; Paul Shannon had low net score, and Everett Walker led in the kicker tournament.

David Webber, Franklin Institute, was general chairman. He was assisted by Alfred Hunt of Hunt-Marquardt Co., who ran the golf tournament, and Harry Stanton of the Boston Globe, who supervised the auto display.

California State Polytechnic College

Student Branch members made three field trips in two days on May 4 and 5—visiting Western Airlines' maintenance station, General Motors' Buick - Oldsmobile - Pontiac assembly plant, and Kaiser Steel Corp.

They saw all phases of repair and overhaul of airplanes; complete car assembly and finishing operations; and steelmaking from ore to finished product.

—Donald B. Hunter

SAE National Tractor Meeting

Sept. 12-14, 1950

Hotel Schroeder

Milwaukee, Wis.

TUESDAY, Sept. 12

9:30 a.m.

Welcome to Milwaukee
—H. M. WILES, Chairman, SAE Milwaukee Section

A. F. MEYER, JR., Chairman

Use of Reduced Scale Models in Heavy-Duty Equipment Design
—R. A. BECKWITH, Koehring Co.

Earthmoving Equipment Design from the User's Point of View
—H. E. FARNAM, JR., M. A. Hanna Co.

Earthmoving Equipment on the Minnesota Iron Ranges
—J. H. Hearding, Jr., Oliver Iron Mining Co.

(Sponsored by Construction and Industrial Machinery Subcommittee)

1:30 p.m.

P. J. SPERRY, Chairman

Review of the Work of Construction and Industrial Machinery Technical Committee
—J. W. BRIDWELL, Caterpillar Tractor Co.

Winterization of Construction Equipment
—R. W. BEAL, Engineer Research and Development Laboratories, Fort Belvoir

Proving Ground versus Field Testing
—P. H. SPENNETTA, Caterpillar Tractor Co.

(Sponsored by Construction and Industrial Machinery Subcommittee)

WEDNESDAY, Sept. 13

9:30 a.m.

K. L. MAGEE, Chairman

The Elements of Metal-Arc Welded Design
—L. C. BIBBER, Carnegie-Illinois Steel Corp.

Welding Design—Resistance Type
—F. A. BODENHEIM, Federal Machine & Welder Co.

(Sponsored by Implement Subcommittee)

1:30 p.m.

H. W. DELZELL, Chairman

The Effect of Lug Height and of Rim Width on the Performance of Farm Tractor Tires. (Partial Report on cooperative research program of U. S. Department of Agriculture and U. S. Rubber Co.)
—I. F. REED, U. S. Department of Agriculture, and J. W. SHIELDS, U. S. Rubber Co.

Design by Measurement
—W. T. BEAN, JR., Consulting Engineer

(Sponsored by Tractor and Farm Machinery Activity)

THURSDAY, Sept. 14

9:30 a.m.

W. H. WORTHINGTON, Chairman

Hydraulic Control Systems for Farm Tractor Implements
—H. A. FERGUSON, International Harvester Co.

(Sponsored by Tractor and Farm Machinery Activity)

1:30 p.m.

E. W. TANQUARY, Chairman

Progress Report—Hydraulic Cylinder Standardization
—E. W. TANQUARY, Chairman, Engineering Advisory Committee, Farm Equipment Institute; and International Harvester Co.

Panel Discussion—Stampings to Replace Forgings and Castings
—Representatives of stamping, fabricating, and equipment companies

DINNER

7:00 p.m. Thursday, Sept. 14

W. H. WORTHINGTON, Chairman
A. T. COLWELL, Toastmaster
JAMES C. ZEDER, SAE President

"America's Future Oil Supplies"

DR. ROBERT E. WILSON

Chairman of the Board, Standard Oil Co. (Indiana)

NATIONAL MEETINGS

MEETING	DATE	HOTEL
WEST COAST	August 14-16	Biltmore Los Angeles, Calif.
TRACTOR	Sept. 12-14	Schroeder Milwaukee, Wis.
AERONAUTIC and AIRCRAFT Engineering Display	Sept. 27-30	Biltmore Los Angeles, Calif.
TRANSPORTATION	Oct. 16-18	Statler, New York City
DIESEL ENGINE	Nov. 2-3	Knickerbocker Chicago, Ill.
FUELS and LUBRICANTS	Nov. 9-10	Mayo Tulsa, Oklahoma
ANNUAL MEETING and Engineering Display	1951 Jan. 8-12	Book-Cadillac, Detroit

SAE SECTION
for

Baltimore

Chairman: **Raymond T. Long**, president, Raymond T. Long Co.
Vice-chairman: **George L. Coleman**, transportation supervisor, Southern States Cooperative, Inc.; vice-chairman, Aeronautics: **Albert S. Polk, Jr.**, senior layout designer, Glenn L. Martin Co.; vice-chairman, Transportation & Maintenance: **Harold D. Duppstadt**, automotive engineer, Department of Army, Automotive Division, Development & Proof Services, Aberdeen Proving Ground; treasurer: **Ward L. Bennett**, superintendent of equipment, Baltimore Transfer Co.; secretary: **Richard L. Ashley**, vice-president (general manager), Ashley Chevrolet Sales, Inc.

British Columbia

Chairman: **J. R. W. Young**, professor, head Agricultural Engineering Department, University of British Columbia.
Vice-chairman: **Burdette Trout**, sales, Truck Parts & Equipment, Ltd.; vice-chairman, Fuels & Lubricants: **Edward B. Sleigh**, lubricating engineer, Shell Oil Co. of Canada, Ltd.; vice-chairman, Transportation & Maintenance: **Alan B. Reid**, truck sales manager, Ross Baker Motors, Ltd.; treasurer: **Edward C. Howell**, transportation manager, Evans, Coleman & Evans, Ltd.; secretary: **John B. Tompkins**, editor, manager, Westrade Publication.

Buffalo

Chairman: **Robert D. Best**, test engineer, Fredric Flader, Inc.
Vice-chairman: **Robert W. Morgan**, chief engineer, Fedders-Quigan Corp.; secretary-treasurer: **Clifford J. Lane**, engineering consultant.

Canadian

Chairman: **Malcolm P. Jolley**, general manager, Canadian Acme Screw & Gear, Ltd.
Vice-chairman: **Denis C. Gaskin**, vice-president, general manager, Studebaker Corp. of Canada, Ltd.; vice-chairman, Hamilton District: **Arthur A. Scarlett**, vice-president (engineering), International Harvester Co. of Canada, Ltd.; vice-chairman, Kitchener District: **William S. Gurton**, president, managing director, Dominion Truck Equipment Co., Ltd.; vice-chairman, Niagara Peninsula: **Charles K. Edward**, purchasing manager, Atlas Steels, Ltd.; vice-chairman, Oshawa District: **F. R. Stephens**, experimental engineer, General Motors of Canada, Ltd.; vice-chairman, Quebec District: F. W. Miller, vice-president, general manager, Collins & Aikman of Canada, Ltd.; vice-chairman, Sarnia District: **Karl R. Chalmers**, Canadian manager, Parts & Service Division, Electric Auto-Lite, Ltd.; vice-chairman, Windsor District: **Arthur D. Harris**, chief plant engineer, Ford Motor Co. of Canada, Ltd.; treasurer: **Clifford E. Phillips**, vice-president, charge, sales, Perfect Circle Co., Ltd.; secretary: **Frank G. King**, manager, Canadian Automotive Trade, Maclean-Hunter Publishing Co., Ltd.

Central Illinois

Chairman: **John W. Pennington**, staff engineer, Research Department, Caterpillar Tractor Co.
Vice-chairman: **Theodore M. Fahnestock**, mechanical engineer, Service Engineering Division, Caterpillar Tractor Co.; vice-chairman, Springfield: **John T. Liggett**, assistant chief engineer, Allis-Chalmers Mfg. Co.; treasurer: **James W. Sydnor**, engineer, designer, Caterpillar Tractor Co.; secretary: **Max M. Gilbert**, chemist, U. S. Department of Agriculture, Northern Regional Research Laboratory.

Chicago

Chairman: **Thomas A. Scherger**, engine development engineer, Studebaker Corp.
Vice-chairman: **Jack E. Kline**, automotive engineer, Standard Oil Co. (Ind.); vice-chairman, Aircraft: **Henry G. Tarter**, assistant manager, Fuel Feed Engineering, Bendix Products Division, Bendix Aviation Corp.; vice-chairman, Engineering Materials & Production: **Harold W. Browall**, metallurgist, Inland Steel Co.; vice-chairman, Fuels & Lubricants: **Maurice L. Hamilton**, assistant director, Engineering Laboratory, Sinclair Refining Co., Research & Development Department; vice-chairman, Parts & Accessories: **David C. Peterson**, director, engineering and manufacturing, Division I., Stewart Warner Corp.; vice-chairman, Passenger Car: **A. G. Laas**, executive engineer, Studebaker Corp.; vice-chairman, Tractor, Industrial Power & Diesel Engines: **H. Wade Barth**, chief powerplant engineer, Electro-Motive Division, General Motors Corp.; vice-chairman, Transportation & Maintenance: **Eric W. Lager**, president, Voltz Bros., Inc.; vice-chairman, Truck & Bus: **Fred B. Lautzenhiser**, consulting engineer, Motor Transport, International Harvester Co.; treasurer: **Lloyd F. Overholt**, chief engineer, Mechanical Research & Test Division, Industrial Power Engineering Department, International Harvester Co.; secretary: **Robert C. Wallace**, Executive engineer, Diamond T Motor Car Co.

Cincinnati

Chairman: **William M. Seitz**, superintendent of equipment, Cincinnati Newport & Covington Railway Co., Inc.
Vice-chairman: **Gus A. Broetzler**, fleet & maintenance superintendent, Coca-Cola Bottling Works Co; vice-chairman, Students: **Fred W. Biederman**, vice-president, Biederman Motors Corp.; treasurer: **William L. Suire**, chief engineer, Cincinnati Plant, Trailmobile Co.; secretary: **Lape W. Thorne**, salesman, General Truck Sales, Inc.

Cleveland

Chairman: **Virgil C. Speece**, special equipment engineer, White Motor Co.
Vice-chairman: **Raymond I. Potter**, chief, Fuels & Lubricants Service Div., Standard Oil Co. (Ohio); vice-chairman, Akron-Canton District: **Everett H. Gibbs**, manager, Development Department, Seiberling Rubber Co.; vice-chairman, Aeronautics: **Theodore R. Thoren**, director of development, Thompson Products, Inc.; vice-chairman, Transportation & Maintenance: **Philip S. Rockwood**, mechanical engineer, Cleveland Transit System; vice-chairman, Truck & Bus: **Rodney O. McSherry**, experimental engineer, Oliver Corp.; treasurer: **Robert E. Cummings**, manager, engineering and sales, Thompson Products, Inc.; secretary: **Edward K. Brown**, district manager, Crane Packing Co.

Dayton

Chairman: **David D. Bowe**, sales engineer, Aeroproducts Division, General Motors Corp.
Vice-chairman: **Charles I. Lathrem**; vice-chairman Aircraft: **F. H. Carroll, Jr**, project engineer, U. S. Air Forces; vice-chairman, Columbus District: **Marion L. Smith**, in-

OFFICERS 1950-51

structor, Ohio State University; vice-chairman, Springfield District: Lemar T. Cox, resident engineer, International Harvester Co.; treasurer: B. B. Brombaugh, supervisor, Engineering Test Section, Inland Mfg. Division, General Motors Corp., secretary: Frank W. Brooks, project engineer, Moraine Products Division, General Motors Corp.

Detroit

Chairman: **L. Irving Woolson**, operating manager, Chrysler Corp., DeSoto Division.

Vice-chairman: **Edward N. Cole**, works manager, Cadillac Motor Car Division, General Motors Corp.; vice-chairman, Aeronautics: **Milton J. Kittler**, vice-president, chief engineer, Holley Carburetor Co.; vice-chairman, Body: **Kenneth E. Coppock**, director, experimental and development section, Fisher Body Division, General Motors Corp.; vice-chairman, Junior Activity: **Carl T. Doman**, national service manager, Ford Motor Co.; vice-chairman, Mid-Michigan Division: **Clayton L. Nelson**, assistant resident engineer, Chevrolet-Flint Mfg. Division, General Motors Corp.; vice-chairman, Passenger Car: **Max M. Roensch**, research coordinator, Ethyl Corp.; vice-chairman, Production: **James H. Booth**, chief engineer, Detroit Plant, Thompson Products, Inc.; vice-chairman, Regional: **Clayton L. Nelson**, assistant resident engineer, Chevrolet-Flint Mfg. Division, General Motors Corp.; vice-chairman, Students: **Harry E. Chesebrough**, chief engineer, Chrysler Corp, Dodge Division; vice-chairman, Truck & Bus: **F. Emil Sandberg**, truck engineer, Ford Motor Co.; treasurer: **George A. Delaney**, chief engineer, Pontiac Motor Division, General Motors Corp.; secretary: **Philip H. Pretz**, assistant chief engineer, Lincoln-Mercury Engineering Department, Ford Motor Co.

Hawaii

Chairman: **Stephen J. Miehlstein**, superintendent of maintenance, Hawaiian Airlines, Ltd.

Vice-chairman: **Fred Hedemann**, vice-president operation, Oahu Transport Co., Ltd.; vice-chairman, Aeronautics: **Leland E. Copple**, territorial manager, Firestone Tire & Rubber Co.; vice-chairman, Hawaii: **Byron B. Peetz**, automotive superintendent, Laupahoehoe Sugar Co.; vice-chairman, Maui: **Wallace L. Doty**, field engineer, harvesting superintendent, Hawaiian Commercial & Sugar Co., Ltd.; treasurer: **James S. Moore**, general manager, Marine Automotive Engineering; secretary: **Charles R. Baptiste**, parts salesman, Schuman Carriage Co., Ltd.

Indiana

Chairman: **S. A. Silbermann**, president, chief engineer, Metallurgical Service Co., Inc.

Vice-chairman: **Henry L. Elfner**, chief engineer, International Harvester Co.; treasurer: **William P. Wood**, assistant resident engineer, Chevrolet-Indianapolis Division, General Motors Corp.; secretary: **Robert P. Atkinson**, assistant turbine engineer, Allison Division, General Motors Corp.

Kansas City

Chairman: **Ernest L. Bailey**, president, Columbia Truck Leasing, Inc.

Vice-chairman: **John P. Dranek**, service engineer, Scintilla Magneto Division, Bendix Aviation Corp.; vice-chairman, Aeronautics: **Francis L. Spruill**, supervisor, powerplant engineering, Trans World Airlines, Inc.; vice-chairman, Fuels & Lubricants: **Frederick V. Olney**, superintendent of transportation, Gas Service Co.; vice-chairman, Transportation & Maintenance: **Howard F. Dougherty**, assistant superintendent, transportation, Kansas City Power & Light Co.; treasurer: **Kenneth J. Holloway**, Civil Aeronautics Administration; secretary: **Donald G. Reed**, national accounts representative, Sinclair Refining Co.

Metropolitan

Chairman: **Ervin N. Hatch**, senior mechanical engineer, automotive, New York City Transit System, Board of Transportation.

Vice-chairman: **J. Edward Schipper, Jr.**, district representative, National Carbon Co., Inc., vice-chairman, Aeronautics: **S. G. Nordlinger**, director of sales, Ranger Engines Division, Fairchild Engine & Airplane Corp.; vice-chairman, Air Transport: **George T. Hayes**, Convair manager, American Airlines, Inc.; vice-chairman, Diesel Engines: **Lewis F. Moody, Jr.**, staff engineer, Lubricants Department, Socony-Vacuum Oil Co., Inc.; vice-chairman, Fuels & Lubricants: **Neil P. Flynn**, specialist, fuels, Standard Oil Co. (N. J.); vice-chairman, Passenger Car; **Denver F. Geisey**, special representative, fleet sales, Studebaker Sales Corp. of America; vice-chairman, Students: **Joseph G. Liscouski, Jr.**, head, technical department, Academy of Aeronautics; vice-chairman, Transportation & Maintenance: **Robert Gardner**, automotive manager, Lever Bros. Co.; treasurer: **Leslie Peat**; secretary: **William H. Bean**, partner, Engine Equipment Service.

Mid-Continent

Chairman: **William K. Randall**, sales engineer, Carter Oil Co.

Vice-chairman: **Delton R. Frey**, manager, Products Application, Deep Rock Oil Corp.; vice-chairman, Transportation & Maintenance: **W. F. Ford**, superintendent, Product Use Laboratory, Continental Oil Co; treasurer: **Franklin E. DeVore**, fleet engineer, Ethyl Corp.; secretary: **Harold C. Baldwin**, sales engineer, Continental Oil Co.

Milwaukee

Chairman: **Howard M. Wiles**, installation engineer, Waukesha Motor Co.

Vice-chairman: **Charles H. Duquemin**, engineer, LeRoi Co.; treasurer: **Christy L. Spexarth**, assistant chief engineer, Harley-Davidson Motor Co.; secretary: **Richard K. McConkey**, district manager, Industrial Division, Timken Roller Bearing Co.

Montreal

Chairman: **William S. Cowell**, manager, Ferado Division, Atlas Asbestos Co., Ltd.

Vice-chairman: **E. J. Cosford**, vice-president, charge of sales, Canadian Car & Foundry Co, Ltd.; treasurer: **H. L. Barre**, Thompson Products, Ltd.; secretary: **Frederick H. Moody**, manager, industrial sales, Imperial Oil, Ltd.

New England

Chairman: **Alfred Markus**, treasurer, manager, Markus Motor Service, Inc.

Vice-chairman: **Lewis B. Ebbs**, zone parts and service manager, GMC Truck and Coach Division; vice-chairman, Aeronautics: **John D. Works**, district manager, TEK Bearing Co., Inc.; vice-chairman,

Diesel Engines: **Ralph G. Fritch**, special assistant to superintendent, locomotive maintenance, Boston & Maine Railroad; vice-chairman, Fuels & Lubricants: **Danforth M. Googins**, automotive engineer, Socony Vacuum Oil Co., Inc.; vice-chairman, Students: **David S. Webber**, instructor, Franklin Technical Institute; vice-chairman, Transportation & Maintenance: **Tage Hansen**, truck maintenance mechanic, Esso Standard Oil Co.; vice-chairman, Truck & Bus: **Charles H. Meeker**, district representative, GMC Truck & Coach Division; treasurer: **Arnold R. Okuro**, instructor, charge, Automotive Department, Franklin Technical Institute; secretary: **Edward G. Moody**, treasurer, Edward G. Moody & Son, Inc.

Northern California

Chairman: **Edward J. McLaughlin**, supervisor, Engine Fuels Division, California Research Corp.

Vice-chairman: **William G. Nostrand**, vice-president, charge, engineering and sales, Winslow Engineering Co.; vice-chairman, Aeronautics: **James E. Weesner**, maintenance manager, Pan American World Airways; vice-chairman, Diesel Engines: **Ansel Spanier**, regional parts and service manager, GMC Truck & Coach Division; vice-chairman, Fuels & Lubricants: **Robert E. Jeffrey, Jr.**, product application and development engineer, Shell Oil Co., Inc.; vice-chairman, Transportation & Maintenance: **John H. Ritter**, manager of equipment, Pacific Motor Trucking Co.; treasurer: **Elvin B. Lien**, supervisor, lubricating sales, Union Oil Co. of California; secretary: **Donald Wimberly**, research engineer, California Research Corp.

Northwest

Chairman: **Roy T. Severin**, manager, partner, Gasoline Tank Service Co.

Vice-chairman: **Howard Lovejoy**, assistant marine superintenedent, Puget Sound Freight Lines; vice-chairman, Aeronautics: **Davis M. Wood**, design engineer, Boeing Airplane Co.; treasurer: **Alfred P. Nelson**, manager, Automotive Parts Division, Seattle Branch, Wagner Electric Co.; secretary: **Allan D. McLean**, liaison engineer, Kenworth Motor Truck Corp.

Oregon

Chairman: **Charles H. Lewis**, head fuel and lubricant engineer, Standard Oil Co. of California.

Vice-chairman: **Edward A. Haas**, salesman, Ballou & Wright Co.; vice-chairman, Aviation: **Britt M. Smith**, engineering consultant, Engineering Clinic; vice-chairman, Fuels & Lubricants: **Edward C. Nelson**, manager, marine sales, General Petroleum Corp.; vice-chairman, Diesel Engines: **Stanley J. Coffey**, sales, Cummins Diesel Sales of Oregon, Inc.; vice-chairman, Students: **William H. Paul**, professor, automotive engineering, Oregon State College; vice-chairman, Tractors: **J. M. Meaney**, manager, Logging Division, Loggers & Contractors Machinery Co.; vice-chairman, Transportation & Maintenance: **Clarence Bear**, fleet superintendent of maintenance, Hudson-Duncan & Co.; vice-chairman, Truck & Bus: **Roscoe W. Clarke**, field service and sales engineer, Earl Marks Co.; treasurer: **C. A. Dillinger**, owner, manager, Tokheim Pump Agency; secretary: **John B. Clark**, superintendent of Portland shops, Consolidated Freightways.

Philadelphia

Chairman: **Laurence Cooper**, chassis engineer, Autocar Co.

Vice-chairman: **Linn Edsall**, general superintendent, Transportation Division, Philadelphia Electric Co.; vice-chairman, Aircraft: **John Gitz**, chief production engineer, Chase Aircraft Co., Inc.; vice-chairman, Fuels & Lubricants: **John G. Moxey, Jr.**, Sun Oil Co.; vice-chairman, Transportation & Maintenance: **Gavin W. Laurie**, manager, automotive transportation, Atlantic Refining Co.; vice-chairman, Truck & Bus: **B. Frank Jones**, chief engineer, Autocar Co.; treasurer: **A. Milton Miley**, development engineer, Electric Storage Battery Co.; secretary: **Robert W. Donahue**, research engineer, Sun Oil Co.

Pittsburgh

Chairman: **J. Edward Taylor**, chief product engineer, gasoline section, Products Development Department, Gulf Oil Corp.

Vice-chairman: **Warren J. Iliff**, superintendent, maintenance Equitable Auto Co.; vice-chairman, Oil City; **Charles R. Scott**, lubrication engineer, Wolf's Head Oil Refining Co., Inc.; treasurer: **Kenneth G. Scantling**, automotive engineer, Equitable Auto Co.; secretary: **W. J. Kittredge, Jr.**, fleet sales representative, GMC Truck & Coach Division.

St. Louis

Chairman: **Capt. Roy T. Adolphson**, chief product engineer, Sunnen Products Co.

Vice-chairman: **August H. Blattner**, assistant chief draftsman, Carter Carburetor Corp.; vice-chairman, Aircraft: **Frederick H. Roever**, planning engineer, McDonnell Aircraft Corp.; vice-chairman, Diesel Engines: **Leland A. Wendt**, senior engineer, Shell Oil Co., Inc.; vice-chairman, Fuels & Lubricants: **Archie K. Miller**, division staff assistant, industrial and automotive, Socony-Vacuum Oil Co., Inc.; vice-chairman, Students: **Eugene S. Kropf**, director, Air Transportation Department, Parks College of St. Louis University; vice-chairman, Transportation & Maintenance: **Harold C. Glidewell**, superintendent of maintenance, East St. Louis City Lines; treasurer: **Monroe C. Alves**, superintendent of Motor Transportation, Union Electric Co. of Missouri; secretary: **Warren H. Cowdery**, industrial representative, Sinclair Refining Co.

San Diego

Chairman: **William C. Heath**, chief engineer, Solar Aircraft Co.

Vice-chairman: **Joseph H. Famme**, project engineer, Consolidated Vultee Aircraft Corp.; treasurer: **Joseph S. Skurky**, engineering design checker, Solar Aircraft Co.; secretary: **John J. Draney**, design engineer, thermodynamics, Consolidated Vultee Aircraft Corp.

Southern California

Chairman: **Fred O. Hosterman**, hydraulics design specialist, Lockheed Aircraft Corp.

Vice-chairman: **Jack R. Clements**, manager, national fleet sales department, GMC Truck & Coach Division; vice-chairman, Air Transport: **Clarence M. Belinn**, president, Los Angeles Airways, Inc.; vice-chairman, Aircraft: **John O. Findeisen, Jr.**, assistant resident engineer, Thompson Products, Inc.; vice-chairman, Aircraft Powerplant: **John O. Longenecker**, sales manager, aircraft engine division, Continental Sales and Service Co.; vice-chairman, Diesel Engines: **Alfred S. Leonard**, regional manager, Cummins Engine Co., Inc.; vice-chairman, Fuels & Lubricants: **John R. Schmitt**, head fuel and lubricant engineer, Standard Oil Co. of Calif.; vice-chairman, Passenger Car: **Roger M. Mahey**, automotive editor, Los Angeles Daily News; vice-chairman, Production: **George S. Gervais**, trim engineer, National Automotive Fibres, Inc; vice-chairman, Transportation & Maintenance: **William E. Williams**, automotive maintenance engineer, Pacific Electric Railway Co.; vice-chairman, Truck & Bus: **H. C. Schultz**, vice-president, branch manager, Sterling Motors Corp; treasurer: **Edward E. Tuttle**, partner, Tuttle & Tuttle; secretary: **Francis H. Ott**, Union Oil Co. of Calif.

Southern New England

Chairman: **John J. Broderick**, design engineer, American Bosch Corp.

Vice-chairman: **C. Owen Broders**,

designer, Pratt & Whitney Aircraft, Division of the United Aircraft Corp.; vice-chairman, Aeronautics: **Hans Hogeman**, chief engineer, fuel injection department, American Bosch Corp.; treasurer: **Henry J. Fischbeck**, supervisor, metallurgical and chemical processing, Pratt & Whitney Aircraft; secretary: **Alexander M. Watson**, service representative, United Aircraft Service Corp.

Spokane-Intermountain

Chairman: **Peter J. Favre**, Wasatch Oil Co.

Vice-chairman: **Ernest J. Eldenburg**, partner, Washington Auto Carriage Works; treasurer: **Dwight F. Hume**, manager, truck division, Ernie Majer, Inc.; secretary: **George W. Shields, Jr.**, buildings, supplies and motor vehicle supervisor, Pacific Telephone & Telegraph Co.

Syracuse

Chairman: **Edwin B. Watson**, associate professor of mechanical engineering, Cornell University.

Vice-chairman: **L. R. Parkinson**, chairman, department mechanical engineering, Syracuse University; vice-chairman, Elmira-Ithaca: **Samuel K. Wolcott, Jr.**, engineer in charge of engines and pumps, American LaFrance Foamite Corp.; vice-chairman, Sidney: **Richard B. Clark**, assistant chief engineer, Scintilla Magneto Division, Bendix Aviation Corp.; secretary-treasurer: **David T. Doman**, project engineer (special assignment), Porter-Cable Machine Co.

Texas

Chairman: **Earl L. Casey**, general plant superintendent, laboratory and manufacturing division, Geophysical Service, Inc.

Vice-chairman: **Ernest J. Mailloux**, assistant chief engineer, Chance-Vought Aircraft Division, United Aircraft Corp.; vice-chairman, Houston: **E. J. Strawn**, regional automotive manager, Shell Oil Co, Inc.; treasurer: **Horrell Gus Erickson**, chief engineer, Luscombe Airplane Corp.; secretary: **Richard W. Hoyt**, chief engineer, Double Seal Ring Co.

Twin City

Chairman: **Frank A. Donaldson, Jr.**, vice-president, Donaldson Co., Inc.

Vice-chairman: **Wayne E. Schober**, chief engineer, Viking Tool & Die Co.; treasurer: **W. Fenton Miller**, chief engineer, Toro Mfg. Corp.; secretary: **S. Reed Hedges**, automo-

tive engineer, Minneapolis-Moline Co.

Virginia

Chairman: **James A. Kline,** Jr., proprietor, Kline Co.

Vice-chairman: **Robert P. Knighton,** garage superintendent, Esso Standard Oil Co.; treasurer: **Percy J. Carr,** president, Carr-Woodall Tire Service, Inc.; secretary: **F. M. Hutcheson,** general sales manager, Motor Parts Corp.

Washington

Chairman: **Herbert A. Roberts,** president and general manager, Roberts Bros., Co.

Vice-chairman: **Bertram Ansell,** partner, Ansell & Goda; treasurer: **Douglas K. Bonn,** special representative, Government department, United States Rubber Co.; secretary, **John B. Hulse,** secretary and manager, Truck-Trailer Mfrs. Association, Inc.

Western Michigan

Chairman: **Raymond A. Snyder,** sales manager, Original Equipment Ring Division, Sealed Power Corp.

Vice-chairman: **George E. Dake, Jr.,** engineer, Fitzjohn Coach Co.; vice-chairman, Grand Rapids: **Maurice W. Bolster,** district industrial salesman, Shell Oil Co., Inc.; treasurer: **Robert B. Hawkins,** sales engineer, Sealed Power Corp; secretary: **William H. Kennedy,** diesel engineer, Continental Motors Corp.

Wichita

Chairman: **M. L. Carter,** chief chemist and treasurer, Southwest Grease & Oil Co., Inc.

Vice-chairman: **Virgil W. Hackett,** chief draftsman, Cessna Aircraft Co.; treasurer: **William A. Day,** assistant project engineer, Beech Aircraft Corp.; secretary: **Gomer W. Jones,** design engineer, Beech Aircraft Corp.

GROUPS

Atlanta

Chairman: **Wendell P. Turner,** regional service engineer, Chevrolet Motor Division, GMC.

Vice-chairman: **Charles F. Whitmer,** assistant to supervisor of automotive equipment, Georgia Power Co.; treasurer: **Karl H. Nonweiler,** division lubricants manager, Shell Oil Co., Inc.; secretary: **Zack T. Layfield, Jr.,** general manager, John Rogers Co.

Colorado

Chairman: **Charles L. Carpenter,** product engineer, superintendent,

industrial department, Goor's Porcelain Co.

Vice-chairman: **Kenneth G. Custer**, assistant technical director, Gates Rubber Co.; treasurer: **Rollin F. Allyne,** director of engineering, Pacific Intermountain Express Co.; secretary: **Francis E. Raglin**, assistant transportation engineer, Public Service Co. of Colorado.

Mohawk-Hudson

Chairman: **A. Frank Geiler,** president and general manager, Schenectady Railway Co.

Vice-chairman: **Lester W. Anthony**; secretary-treasurer: **Frank Baker,** designer, American Locomotive Co.

Salt Lake Group

Chairman: **Lyle G. Garnas,** salesman, International Harvester Co.

Vice-chairman: **Stanley W. Stephens**, shop foreman and service engineer, Koepsel & Love; secretary-treasurer: **Dean C. Despain,** garage superintendent, Holsum Bread Co.

Williamsport

Chairman: **John W. Hospers,** analytical engineer, Lycoming Division, Avco Mfg. Corp.

Vice-chairman: **D. S. King,** assistant chief engineer, Lycoming Division, Avco Mfg. Corp.; treasurer: **Horace W. Epler,** assistant chief draftsman, Lycoming-Spencer Division, Avco Mfg. Corp.; secretary: **Adam E. Sieminski,** chief draftsman, Lycoming Division, Avco Mfg. Corp.

Engineers at G.E.

Continued from page 74

field?" Such training is provided at General Electric by a number of specialized training courses. These all have competitive requirements and accept candidates from the test engineering group only through competitive examinations or interviews. Included are the Sales Engineering Course, the Advanced Engineering Program, the Creative Engineering Program, etc.

Sales Engineering Program

Those successful in being selected for the sales engineering program enter upon a three year practical training course. In the first year the engineer goes through the test course and attends the classroom work previously described. In his second year he is assigned responsibilities in a design engineering section so he can thoroughly understand this function during his later sales life. The third year, he is assigned responsibilities in a commercial section of our sales department at the factory. Here he becomes involved in pricing policies, application studies, and so forth. At the conclusion of this three-year period, he is eligible to go to one of our district sales offices as sales engineer.

Advanced Engineering Program

Men with high engineering ability are selected competitively for the Advanced Engineering Program. Upon acceptance, the engineer is removed from the Test Course, and is given a series of rotating assignments in our various engineering divisions and laboratories. These assignments are generally three months long and occupy all the men's working time. In these assignments the men are responsible for the solution of some of the newest and most difficult company problems. Meanwhile a strenuous classroom program is given.

We try to discover geniuses even though we can't make them. The

Creative Engineering Program—a very highly selective course—was devised to help those few individuals with apparent inventive genius to develop their potential.

Our theory is that, given an individual with a burning desire, much can be done to speed his development. Men are selected for this program by examination, interview, and past performance in college and on test. Those entering the program are given rotating assignments lasting from three to six months each in our various laboratories or engineering divisions. Every effort is made to put the student on a sort of master-apprentice basis leading inventors and laboratory geniuses in the company.

Although this program is relatively new, many graduates have contributed many important new developments to our Company.

Manufacturing Engineering Programs

In like manner young engineers may enter the Manufacturing Engineering Program. This follows those previously discussed in that for a two to three year period the student is given rotating assignments in various manufacturing operations simultaneously with a carefully planned program of class work.

Thus, we strive to answer the second problem of the young engineer: How can I train for future advancement?

By giving our young college graduates a "breeding period" on the Test Program during which time they have the opportunity to work through many doors before making up their minds which one to walk through, we allow them opportunity of selection which results in personal happiness and maximum chance for advancement.

It helps us and our young men to eliminate—or certainly to minimize—oval pegs in round holes. (Paper was presented at SAE Central Illinois Section panel on "Growing in Engineering," March 20, 1950.)

Students Given Hints for Engineering Success

Based on paper by

ROBERT FLETCHER

Hyster Co.

PLANNING a career in engineering must be approached like any other project: first, by analyzing the problem; second, by blueprinting a course of action. The young engineer must first determine his objective in life; then visualize it; then organize a plan of attack.

While everyone's plans, objectives and means of attaining them will differ, there are a few steps that will always help:

1. Get all the facts about what will be required of you.
2. Analyze and group them in a logical but flexible order for accomplishment.
3. Make a timetable for the plan.
4. Go into action, concentrating on one step at a time.
5. Make adjustments in the plan when circumstances alter developments.
6. Keep objectives clear at all times.

Once this engineering career is launched, there are a number of ways to encourage its growth and broaden its scope—advanced education, company training programs, company-sponsored graduate study, teaching, participation in technical society activities, technical hobbies—and encouraging a general inquisitiveness that will help the process of "growing in engineering." (Paper was presented at SAE Central Illinois Section panel on "Growing in Engineering," March 20, 1950.)

Tighter Traffic Controls Predicted for Jetliners

Based on paper by

S. P. SAINT

Air Transport Association of America

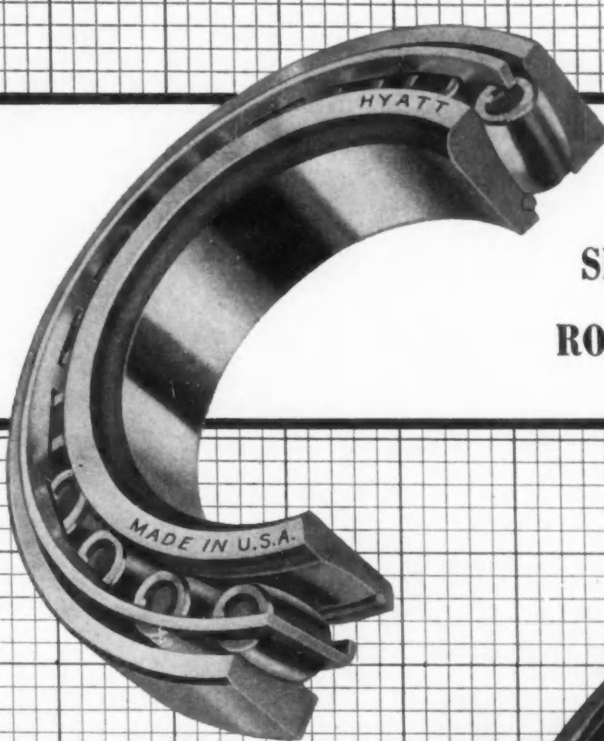
IT will be possible to mix jet airliners with conventional propeller transports in the same traffic patterns. But the jet will need better, not different, traffic control.

Properly designed, the future traffic control system should accommodate a mixture of the two aircraft types. In fact, mixing both types will make terminal airports more efficient than with jet airplanes alone.

One approach is to segregate air traffic classes according to speed, communications, navigations and traffic control equipment carried. On land highways, slow traffic keeps to the right to make more efficient use of the road. Both slow and fast drivers benefit from this more efficient use of the taxpayer's concrete. The same goes for introduction of jets into the propeller-operated airways.

Tight air traffic control is a must if jets are to be operated with reasonable safety and economy. Three jet aircraft characteristics make this so.

First, jets must be permitted to fly very high and very fast; otherwise, the penalty in fuel consumption becomes intolerable. Second, the jet must have reasonable assurance of prompt landing on arrival at destination. It doesn't carry enough of a fuel margin



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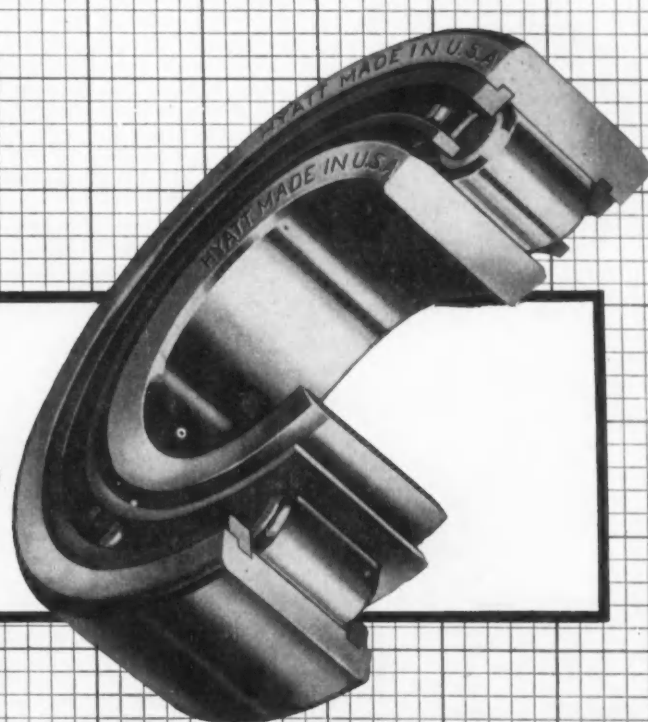

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STRAIGHT CYLINDRICAL
ROLLER BEARINGS

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HYATT ROLLER BEARINGS

to sit in a stack and wait its turn to land. Third, if the originally intended flight path or airport is blocked for unexpected reasons, the jet airplane must be diverted promptly to an alternate airport.

To satisfy these stringent jet needs, the traffic control system accommodating both airplane types must meet higher standards in the three traffic control phases—(1) organizing traffic flow before it reaches the terminal area, (2) accepting flights in the terminal area, arranging landing sequence, and adjusting sequence between landings, and (3) insuring safe separation between flights.

In the first phase, the jet pilot's requirements are basically no different than those flying propeller craft. But he must know within much closer limits what anticipated delay there will be in handling his airplane. He can be given a priority for landing, so that he won't be delayed if he is late.

Both types also require the same features in phase two, approach control. They want control to have maximum freedom to juggle and rearrange final landing sequence, to divert traffic from a blocked runway, or to shift unexpected peak loads.

Adjusting final landing sequence, the third traffic control operation, is a precision job. Loose tolerances in placing flights on final approach to the runway will waste valuable runway time.

High speeds of jet transport also demand avoidance of thunder storms. Heavy rain becomes a hazard at 500 mph. Turbulence gets dangerous. Hail means almost certain destruction at these speeds. Airborne radar can point out these dangers and may hold the answer to safe operation. (Paper "The Impact of Jets on Air Traffic Control," was presented at SAE National Aeronautic Meeting (Spring), New York, April 18, 1950. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Cathodic Corrosion —Cause and Prevention

Based on paper by

HIRAM WALKER

Harrison Radiator Division, General Motors Corp.

THE mechanism of galvanic corrosion and how to prevent it are detailed by Hiram Walker in his paper.

He says all metals tend to combine with other elements, some more than others. When two metals are electrically coupled and immersed in a conducting solution, the difference in their solutions potentials will cause current flow through the solution and forms an electrical bond between them.

At one electrode, electrons will be discharged to the solution and will liberate hydrogen. This is called the cathode and is the more negative of the two metals. At the other electrode, the anode, metal ions form and electrons pass through the electrical bond to the other metal, where they are consumed in producing hydrogen.

Corrosion at Anode

Formation of these metal ions at the anode, says Walker, is the chief corrosion process at the anode metal surface. This same galvanic or electrochemical corrosion also is responsible for rusting of steel, chalky corrosion of galvanized iron, and green tarnishing of brass.

Walker points out that most metals and alloys are not homogeneous. They

are made up of a number of phases of the metal. Each of these component parts of the metal or alloy has its own peculiar potential characteristics. Result is that the heterogeneous components in the surface perform as separate microscopic electrodes. Some are anodes, others cathodes.

To counteract this local cell action, cathode currents from an external source can be imposed on these local currents. These applied cathodic currents, if great enough, cause current flow from local anode surface to diminish.

Walker describes this process and tells how cathodic protection is put to work in preservation of underground structures, ship hulls, steel piling, docks, heat exchangers, condensers, and pipe lines carrying sea water. (Paper "Cathodic Control of Corrosion," was presented at SAE Buffalo Section, Feb. 23, 1950. This paper is available in full in photolithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Nine Ways to Improve Commercial Air Travel

BASED ON PAPER BY

R. L. TURNER

Eastern Air Lines, Inc

AIR travel must become more attractive to the customer before it becomes more profitable to the airlines. Here are nine ways to do it:

1. Customers want to be able to see out. Seats should be rearranged with relation to windows so that even those on the aisles can see out.

2. Why not go to high-wing aircraft and thus cut out the long flights of stairs necessary to get into an airplane?

3. Provisions should be made for carrying pets. Many vacationers want their pets with them. Airlines lose these potential customers because there is no way of transporting pets on a passenger liner at present.

4. The ride must be quieter. Noise from the ventilating system is annoying. Hydraulic and electric system noises are loud enough to frighten some people.

5. Short-range aircraft should be able to get to smooth air as soon as possible as do long-range airplanes. A calm trip is just as potent a selling point as speed.

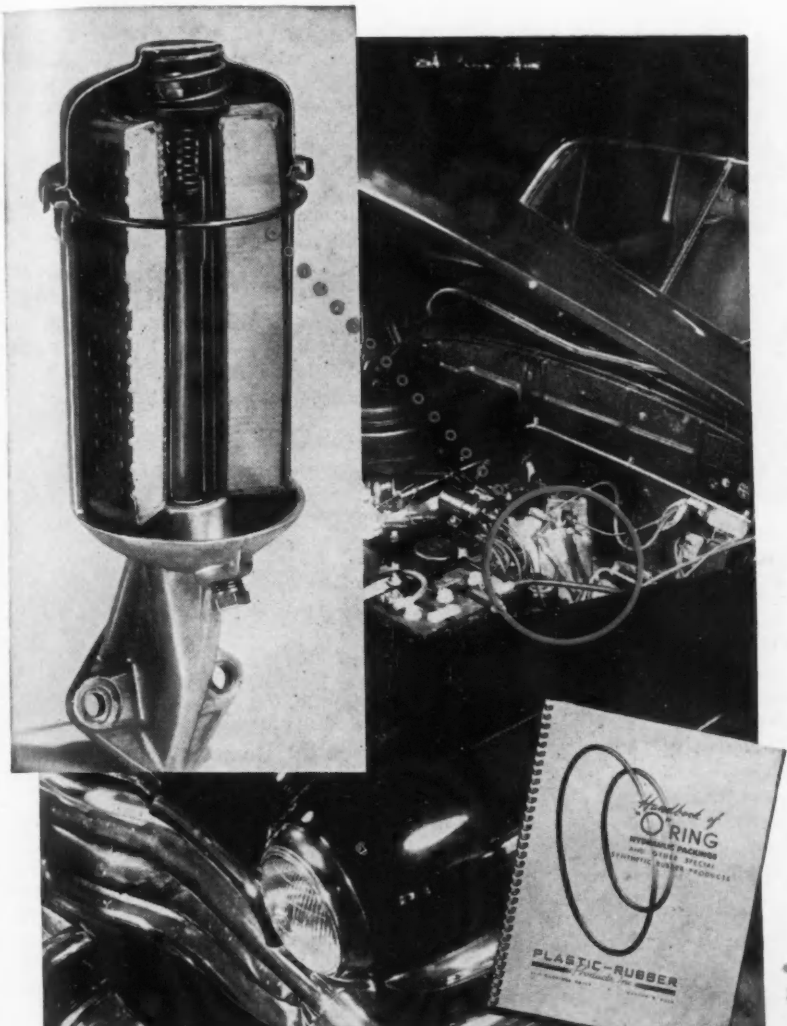
6. Meals must be served quickly, but in a way that creates the impression of gracious, unhurried service.

7. Various seating arrangements departing from the conventional are good sales points. Among those desirable are three abreast, for business associates or a family traveling together; four seats facing each other in pairs, for card players; and two or more seats that can be put together for stretcher cases.

8. There should be lots more room in airplanes to stow baggage. First, it will speed baggage handling and prevent delays after landing. Second, it will cut down damage to baggage.

9. Finally, something must be done to cut down the time it takes getting to and from the airport, often longer than the flight itself. It's probably the hardest problem of all to solve, but it must be done. (Paper "Air Speed Doesn't Mean a Thing," was presented at SAE National Aeronautic Meeting (Spring), New York, April 18, 1950. This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

THIS "O" RING SEAL IS "Boiled in oil!"



A single "O" Ring Seal serves as the leakproof cover gasket on this Micronic Oil Filter, one of several manufactured by PUROLATOR PRODUCTS, INC. — Newark, N. J. For this automotive application, in which the "O" Ring is constantly subjected to hot engine oil, PRP engineers produced an "O" Ring from a special heat-resisting rubber compound, with particularly favorable "set" characteristics to insure maximum durability.

For specialized applications, and for standard applications, "O" Rings frequently provide the most effective solution to many design and production problems. "O" Rings save weight and space, and are designed for leakproof service with gases, water, oil and special fluids.

We'll gladly discuss your product design and manufacturing problems with you, to show you how and why "O" Rings can simplify those problems and help make yours a better product. Write today, without obligation, for complete details.

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About SAE Members

Continued from page 83

JAMES J. MALONE, who graduated last January from Illinois Institute of Technology, is now an engineering technician in the engine test laboratory of The White Motor Co., Cleveland, Ohio.

PERRY G. ACKERMAN is now connected with Douglas Aircraft Co., El Segundo, Calif., in the capacity of test engineer for the controls design group. He graduated last February from the University of Michigan.

RALPH HULICK is employed as a draftsman with the Aerojet Engineering Corp., Azusa, Calif. The company is engaged in jato and rocket research.

THOMAS G. TAXELIUS is now connected, in the capacity of cartographic draftsman, with the U. S. Coast and Geodetic Survey, Seattle, Wash.

GEORGE J. WAGNER, who graduated in June from the University of Wisconsin, is a trainee with the Central Foundry Division, GMC, Defiance, Ohio.

ROGER WANDA, formerly a student at Cal-Aero Technical Institute, is now an engineering draftsman with Beech Aircraft Co., Wichita, Kans.

RICHARD F. CREERON, a June graduate of the University of Massachusetts, is now a trainee for automotive specialist with National Carbon Division of Union Carbide & Carbon Corp.

Applications Received

The applications for membership received between June 10, 1950 and July 10, 1950 are listed below.

Atlanta Group

John Fleming Hassell.

Baltimore Section

Frederick T. Sadler.

British Columbia Section

Frank Edward Ashdown.

Canadian Section

Elvie Lawrence Smith

Central Illinois Section

Gordon C. Gregory, Rudolph Lenich.

Chicago Section

Grant Hallman Arrasmith, Harold S. Bentley, David R. Blair, Norman L. Booher, Richard J. Chwalek, Melvin Joseph Crompton, Frederick C. Davis, Norman G. Esbrook, Russell Charles Fink, James A. Guske, Milton Kamins, Emil Kondracsek, Edward Walter Policht, Robert A. Pritzker, Alden B. Staples, Marshall Hoyt Wright.

Cincinnati Section

Kenneth Kinnaird.

Cleveland Section

Donald M. Berges, Robert Dinda, Raymond S. Gresko, Ralph R. Leo, Lloyd E. Morris, Lawrence J. Nemeth.

Colorado Group

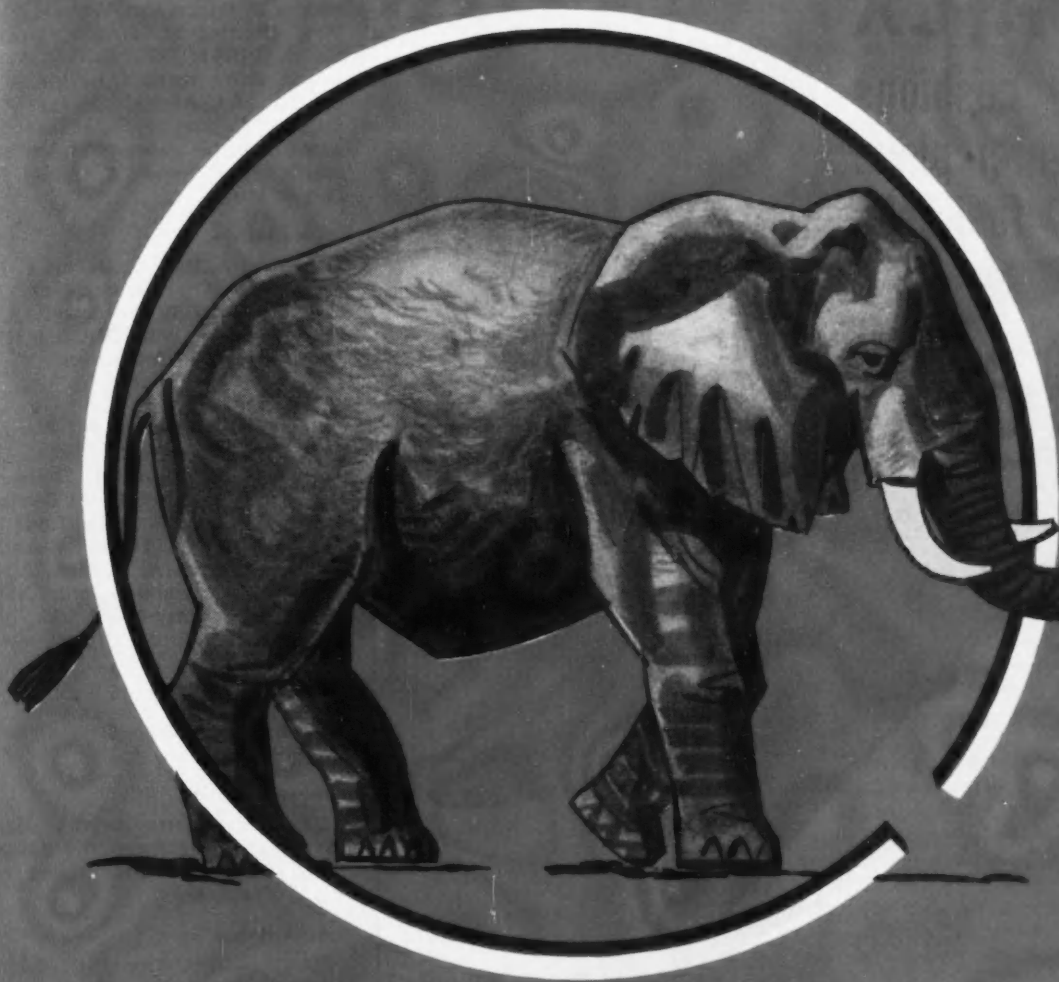
Ralph Edward Metsker.

Dayton Section

James W. Ledbetter.

Detroit Section

Charles J. Augey, Joseph Earl Austerberry, James John Bennett, Robert D. Chrisman, James W. Cooper, Jr., Arthur F. Dicker, Jr., J. R. Forrester, Jr.,



Helma U. Fuhrmann, William A. Hambley, Charles M. Heinen, Robert B. Hillen, Robert D. Holbrook, Abraham Karapetian, Norman Levine, William Brooks McConaghy, George R. McMullen, E. Stephen Madaras, Robert Arthur Meade, James Oldham, Donald Smith Pike, Richard C. Teasel, Robert Lionel Yung.

Indiana Section

William A. Barnes, Robert F. Keller, Raymond P. Koster, Jack Dallas Peebles, Roger W. Pocock, L. A. Rice, William Baker Seth, Milburn Richard Smith, Jerry G. Tomlinson.

Metropolitan Section

Edward L. Beaudry, Jr., Walter Edward Benulis, Julius Blank, Lee J. Bregenzer, Agostino M. Dolza, John Henry Dove, Harold V. Dumbleton, Eugene Robert Ganssle, Isaac Lewis Ginevsky, Paul K. Heim, Alexander M. Kizyma, Warren A. Lipman, Albert L. Longarini, Raymond John Novotny, Rudolf E. Rothemund, M. Robert Skrokov, Alfred S. Tauber, John P. Wiethoff.

Mid-Continent Section

Thomas Christian Greenfield, Paul M. Myers.

Milwaukee Section

Horace J. Homrig, Ralph C. Hopkins, Raymond G. Horner, Jr., James W. Mohr, Earl Clausing Thayer, Arvid Gayle Waschek.

Mohawk-Hudson Group

Harry James Donovan, Lawrence Bailey Thurston.

New England Section

Nelson T. McLeod, Jack Young.

Northern California Section

William George Bloxham, Hendrix Ragon Bull.

Northwest Section

Kenneth William Carlson, William N. Wentworth.

Oregon Section

Ralph E. Black.

Philadelphia Section

Joseph Albert Boothroyd, Jr., Roland Whitehurst.

Pittsburgh Section

Russell M. Franks.

St. Louis Section

William Neal Groves.

Southern California Section

Adolph F. Avondo, Francis Marsh Baldwin, Jr., William F. Humphrey, Douglas L. Schultz, John F. Snider.

Spokane-Intermountain Section

Lee Elvin Wood.

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Syracuse Section

John Joseph Devlin.

Texas Section

Joe Walker Morledge, George H. Pollard.

Twin City Section

Herbert Earl Johnson, III, Robert H. Lundquist, Sanford Robert Sinkey.

Virginia Section

Edward Garland Dorsey, Jr.

Washington Section

Robert Louis Meadows, Ralph E. Wainwright, Jack Henry Watters.

Western Michigan Section

John Carl Pataky, Paul L. Vermaire.

Williamsport Group

Rafael H. Brand, Mehmet Ayhan Turkkan.

Outside of Section Territory

Frank A. Falkenthal, William Hebbard Gates, Harrold W. Goodnight, Edward Russell Lower, Jr., N. L. Parks, Elroy Penner, James Leslie Quinnelly, Ralph Glenn Simpson, Jr.

Foreign

Raul Gomes De Paiya, Brazil; Sarup Singh Gill, India; E. Grimshaw, Jamaica; Frank Noel McGowen, England; Munjandira A. Somaya, India.

New Members Qualified

These applicants qualified for admission to the Society between June 10, 1950 and July 10, 1950. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Baltimore Section

William A. Sorrell (J).

British Columbia Section

Edward Barry Sleigh (A), C. Gordon Stewart (M).

Buffalo Section

Paul E. Mohn (M).

Canadian Section

Albert G. Almack (M), Richard A. Cadieux (A), Ashton A. Calvert (M), Frederick E. Doyle (A), Ralph J. Gignac (A), Gordon E. Heaton (A), Ralph T. Hutchinson (A), Robert W. Kolb (M), Douglas Hulse Moore (M), Bruce Derek Newman (J), Frederick E. Newman (M), Frank H. O'Connor (A), E. L. Trenholme (A), Russell Watson (A), Dennis Alfred West (J).

Central Illinois Section

Austin P. McCloud (J).

Chicago Section

Willett S. Chinery (M), Ernest Albert Ferris (M), Stanford J. Friedman (J), John Hamilton (M), Conrad R. Hilpert (M), Robert A. Ostlind (J), Victor Palenske (A), Bernard J. Toale (M), James F. Vojtek (A), Arthur J. Volz (M), Arthur J. Welch (M), Otto J. Wolfer (M).

Cleveland Section

William Bakos (J), John J. Carlin (M), Stewart E. Gail (M), John Lengel (A), Roland Earl Leucht (J), Lovell Shockey (A), Hugh W. Van Camp, Jr. (J).

Dayton Section

Frederic A. Kondrotas (SM).

Detroit Section

Charles F. Austerberry (J), Frank M.

Belyan (M), Robert W. Carbary (A), James M. Chandler (J), Richard L. Dahlgren (J), C. J. Edwards, Jr. (A), Rollo G. Ellis (M), Charles E. Fiske (J), Rudolph J. Gorsky (M), Gene F. LeRoux (J), Thomas P. Mainzinger (J), Vincent Edward Masko (M), Frederick C. Matthaei, Jr. (J), Nelson G. Meagley (M), James G. Morrison (A), John R. Morrow (A), Joseph Albert Oeming (J), Albert J. Rhodes (M), George S. Robinson (M), Arnold Seligson (J), Arnold W. Smith (A), Bernard A. Wilkie (J).

Indiana Section

William A. Fletcher (M).

Kansas City Section

William Bauman (M), Arthur J. Daniel (A).

Metropolitan Section

Eugene Donald O'Reilly (M), Fred E. Rosenstiehl (M), Julian Lewis Spencer (A), Charles T. Stone (A).

Mid-Continent Section

John E. Hendrick (M).

Milwaukee Section

Merrill William Jensen (J), William A. Thomas (J), Norbert M. Vogl (J).

New England Section

Bernard A. Foss (A), J. Alexander Michaud (M).

Northern California Section

Robert C. Jones (M), John G. Mingle, Jr. (J), Neilson Jackson Reese (J).

Northwest Section

Bob Bade (A).

Philadelphia Section

George Alfred Deibert (A), Charles S. Schaevitz (A).

Pittsburgh Section

Norman H. Wachenhut (M).

Southern California Section

Chester A. Elliott (A), Orville Harmer (J), Robert A. Paulbach (A), Ralph C. Schayer (A), Abe J. Victor (M).

Southern New England Section

Louis Fontanella (M), Richard Schuyler Wentink (J).

Texas Section

John Burns (M), Burnett S. Fuess (M), H. L. McMullin (M), S. E. Murphree (A), Thomas H. Pofahl (M), Edward A. Walsh (J).

Twin City Section

Warren W. Beehler (J).

Washington Section

Donald S. Johnson (SM).

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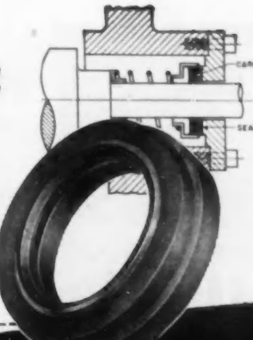


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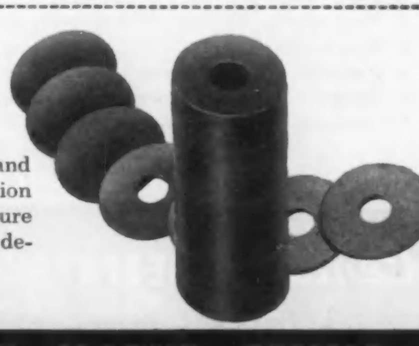

Western Michigan Section

Hubert D. Burnside (A).

Outside Section Territory

Leslie Roy Betteridge (A), Collins L. Carter (M), John M. Olson (J), Howard J. Opper (A), Everett A. Pruess (M), Harvey W. Rockwell (M).

Foreign

Hubert Dietrichs (FM), Germany; Col. Mahidol Hongskul (FM), Thailand; K. D. Joshi (FM), India; Peter Ralph Purves (FM), England.

HAVE YOU Changed Your Address?

So that your SAE mail will reach you with the least possible delay, please keep SAE Headquarters and the Secretary of your local Section or Group advised of any changes in your address. Such notices should be sent to:

1. Society of Automotive Engineers, Inc., 29 West 39th St., New York 18, N. Y.
2. The Secretary or Assistant Secretary of your Section or Group at the addresses listed below:

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R. L. Ashley, Ashley Chevrolet Sales, Inc., 2001 N. B'way, Baltimore 10, Md.

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John B. Tompkins, British Columbia Section, SAE, 1010 Dominion Building, 207 W. Hastings St., Vancouver, B. C., Canada

Buffalo

C. J. Lane, 1807 Elmwood Ave., Buffalo 7, N. Y.

Canadian

F. G. King, Maclean-Hunter Publishing Co., Ltd., 481 University Ave., Toronto, 2, Ont., Can.

Central Illinois

M. M. Gilbert, 175 North St., Peoria, Illinois

Chicago

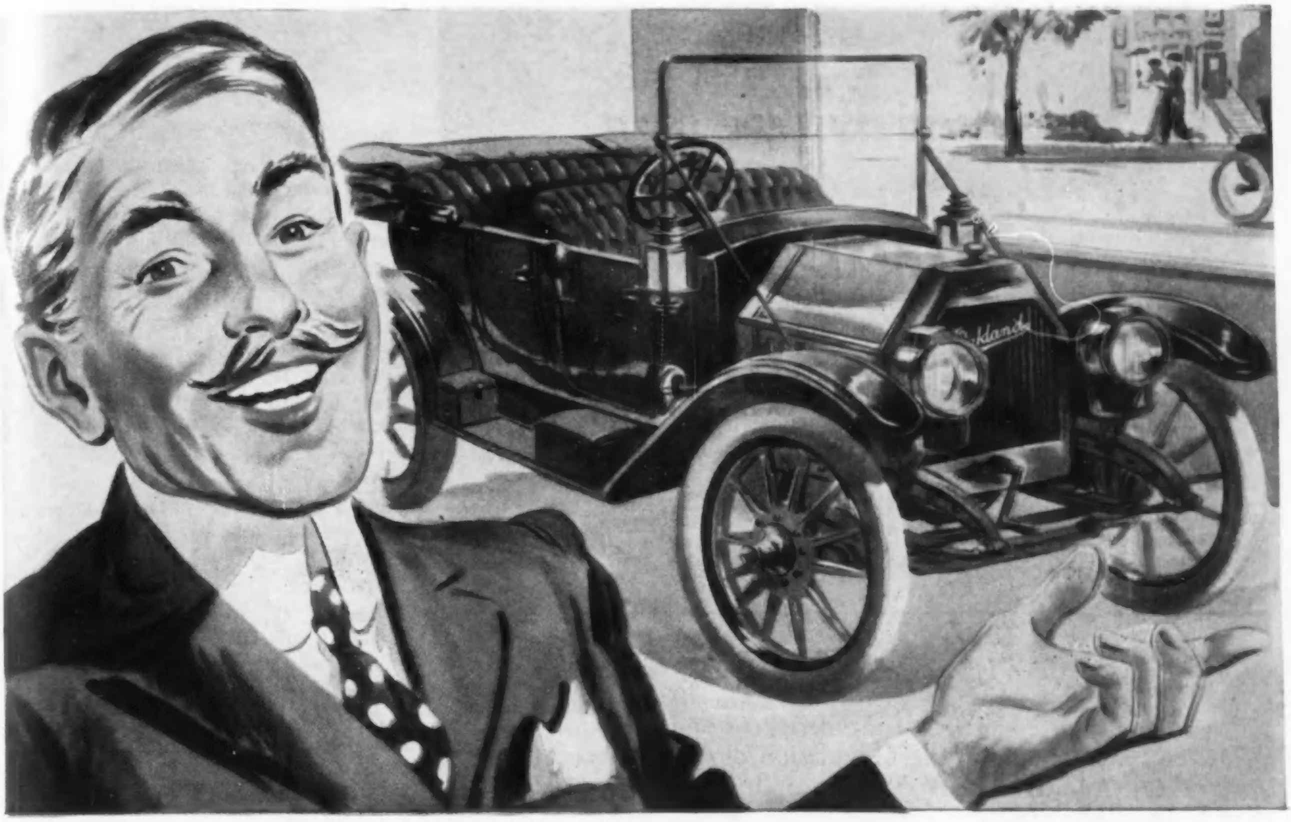
F. E. Ertsman, Chicago Section, SAE, 1420 Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill.

Cincinnati

L. W. Thorne, 615 Maple Ave., Cincinnati 29, Ohio

Cleveland

Miss C. M. Hill, 7016 Euclid Ave.,



Room 210, Cleveland 3, Ohio

Dayton

F. W. Brooks, 1651 Windsor Rd., Dayton 6, Ohio

Detroit

Mrs. S. J. Duvall, 100 Farnsworth Ave., Detroit 2, Michigan

Hawaii

Charles R. Baptiste, Schuman Carriage Co., Ltd., Beretania & Richards St., P. O. Box 2420, Honolulu, T. H.

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R. P. Atkinson, 6217 N. Delaware St., Indianapolis 20, Indiana

Kansas City

Donald G. Reed, 1113 Minnesota Ave., Kansas City, Kansas

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F. F. Smith, Society of Automotive Engineers, 29 W. 39th St., N. Y. 18, N. Y.

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F. H. Moody, 2471 Mayfair Ave., Montreal 28, Que., Canada

New England

E. G. Moody, Edward G. Moody & Son, Inc., Daniel Webster Highway, Box 130, Nashua, N. H.

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Donald Wimberly, Calif. Research Corp., 200 Bush St., San Francisco 4, Calif.

Northwest

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J. B. Clark, Consolidated Freightways, P. O. Box 3618, Portland 8, Oregon

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